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KEY PRESENTS

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A HELL OF A YEAR

COME JANUARY 21, America will have a new commander-in-chief of its armed forces, President Joe Biden, an Irish-American born in Scranton, Pennsylvania. Biden's election victory puts a democrat president back in the White House, and of course a democrat administration back in power. After President Donald Trump's 2016 pledge to increase funding for the armed forces, more money has flowed into the coffers of the US Department of Defense following a period of decline through 2015 and a flat line through 2017. Given America's current economic woes amidst the COVID-19 pandemic, the fact that Biden and his administration have a bunch of domestic issues to tackle, prioritise and fund, might result in Department of Defense budgets being slashed back.

Right now, the US Air Force has ongoing recapitalisation programmes underway for its bomber, fighter, tanker, trainer, and combat rescue helicopters fleets, among many.

Additionally, the Assistant Secretary of the Air Force for Acquisition, Technology and Logistics, Dr Will Roper is pursuing multiple new defence technologies and weapon systems including hypersonic weapons, the Next Generation Air Dominance fighter, and the Air Battle Management System.

You can find coverage of four recapitalization programmes, the B-21 bomber, F-15EX fighter, HH-60W combat rescue helicopter and T-7A Red Hawk trainer in this edition.

America's latest fixed-wing aircraft, the AT-6E Wolverine light attack aircraft is covered in detail with the first artist's impression of its new colour scheme.

However, these systems are all for the future Air Force. What about today's? Legacy systems are well-represented across many of the main mission sets. Accounts of how Air Force Global Strike Command manages the strategic bomber fleet, and how Air Mobility Command tasks its tanker and airlift fleet. It's a great mix featuring the B-2 Spirit, C-5M Super Galaxy, C-17A Globemaster III, EC-130J Commando Solo, F-22 Raptor, KC-135R Stratotanker, and the illustrious RC-135 Rivet Joint.

The big question is, what will President Biden do, recap or cutback?

Whatever your interest in aviation, United States Air Force Air Power Yearbook 2021 is packed full of features about legacy and future aircraft operated by the greatest air force in the world.

Mark Ayton
Editor
United States Air Force Air Power Yearbook 2021

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US Air Force/Mauricio Campino

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RUNNING THE MIGHTY EIGHTH

Mark Ayton profiles Air Force Global Strike Command's Eighth Air Force and its worldwide strategic bomber operations.

A B-52H Stratofortress assigned to the 5th Bomb Wing, Minot Air Force Base North Dakota, parks on the flight line at RAF Fairford, England on September 4, 2020. US Air Force/Airman 1st Class Jesse Jenny

RN DAY EIGHTH Air Force traces its lineage back to the VIII Bomber Command (BC), which came to life on February 1, 1942 at Langley Field, Virginia. In that same month, the VIII BC moved to Buckinghamshire, England, first to Daws Hill and later to High Wycombe, where it established its wartime headquarters in the Wycombe Abbey school for girls. On February 22, 1944, the Army reorganised its Air Forces in Europe by renaming Eighth Air Force as the United States Strategic Air Forces in Europe (now known as the United States Air Forces in Europe). That same day, the VIII BC became Eighth Air Force.

By mid-1944, the Eighth Air Force had a total strength of more than 200,000 people, and it could send more than 2,000 four-engine bombers and 1,000 fighters on a single mission against enemy targets in Europe. For this reason, Eighth Air Force is commonly known as the Mighty Eighth.

Now based at Barksdale Air Force Base, Louisiana, today's Mighty Eighth is responsible for the US Air Force's bomber force and airborne nuclear command and control assets assigned to Air Force Global Strike Command. The co-located Joint-Global Strike Operations Center (J-GSOC) serves as the central command and control node for all operations within Air Force Global Strike Command, orchestrating warfighting, and readiness activities for the Commander, Air Forces Strategic.

Major General Mark Weatherington is the 55th Commander of Eighth Air Force, and also the commander of the Joint-Global Strike Operations Center.

Air Force Global Strike Command

Air Force Global Strike Command (AFGSC) is a major command with responsibility for two legs of America's nuclear triad: intercontinental ballistic missiles and 66 nuclear-capable bombers. AFGSC is also responsible for nuclear command, control, and communications capabilities while simultaneously accomplishing the conventional global strike mission.

Since September 29, 2017, Air Forces Strategic – Air (AFSTRAT-Air) serves as the full-time air component to US Strategic Command (USSTRATCOM) with responsibility for its air missions.

The Joint-Global Strike Operations Center (J-GSOC) plans and executes strategic deterrence and global strike operations for USSTRATCOM air components.

J-GSOC comprises the Joint Air Operations Center (JAOC) which handles the conventional portion of the command's mission, and the Joint Nuclear Operations Center which handles the nuclear portion of the AFGSC's mission.

The JAOC, designated the 608th Air Operations Center plans, directs, commands, controls, monitors, and assesses long-range strike missions.

It has responsibility for executing USSTRATCOM's air tasking cycle through all phases of conflict in support of the J-GSOC, Bomb Wings and Air Force Global Strike Command.

Other mission teams were aligned under the J-GSOC including the four E-4B National Airborne Operations Center (NAOC) aircraft assigned to the 595th Command and Control Group based at Offutt Air Force Base, Nebraska.

Eighth Air Force is one of two active-duty numbered air forces in Air Force Global Strike Command with more than 20,000 active-duty, Air National Guard and Reserve airmen assigned.

The Eighth Air Force has three active-duty wings, two Total Force Integration wings and one detachment assigned (see table). It controls long-range B-1B Lancer, B-2 Spirit and B-52 Stratofortress bombers from bases throughout the United States and at overseas locations such as RAF Fairford, England, and Andersen Air Force Base, Guam.

In accordance with the National Defense Strategy's objectives of strategic predictability and operational unpredictability, the Air Force has modified its force employment model to enable strategic bombers to operate from a broad array of worldwide locations with greater operational resilience.

During BTF deployments to either Fairford of Andersen, airmen get opportunities to work with their counterparts from allied and partner nations, and to focus on the full spectrum of military operations. This in turn provides opportunities to develop the integral elements of agile combat employment (ACE), either working with new entities to provide the strategic strike capabilities or change how the Air Force conducts missions to become more agile.

ACE is a proactive and reactive operational scheme of manoeuvre executed within threat timelines to increase survivability while generating combat power. Bomber operations will utilise the ACE concept, dependent on combatant command requirements.

Other BTF missions have demonstrated the ability to operate in the Arctic region, an important capability for supporting US European Command initiatives, and fulfil objectives in the 2018 National Defense Strategy which reoriented the US military's focus from the Middle East to near-peer challenges in Asia and Europe. This has included short notice operations flown from Eielson Air Force Base, Alaska to anywhere within the EUCOM area of responsibility.

EIGHTH FORCE WINGS

Active-Duty		
5th Bomb Wing	Minot Air Force Base, North Dakota	B-52H
7th Bomb Wing	Dyess Air Force Base, Texas	B-1B
28th Bomb Wing	Ellsworth Air Force Base, South Dakota	B-1B
Total Force Integration		
2nd Bomb Wing and 307th Bomb Wing (Reserve)	Barksdale Air Force Base, Louisiana	B-52H
509th Bomb Wing and 131st Bomb Wing (Air National Guard)	Whiteman Air Force Base, Missouri	B-2

Bomber Task Forces

Air Force Global Strike Command's conventional tasking includes Bomber Task Force (BTF) missions. These are usually flown from either home stations in the United States or from forward locations, primarily RAF Fairford, England in the European theatre and Andersen Air Force Base, Guam in the Indo-Pacific theatre.

BTF missions enable airmen to conduct operations throughout the world at short notice to help maintain global stability and security while enabling the units involved to gain familiarity of flying missions in different regions.

Long-planned, BTF missions are not conducted in response to any current political event in either Europe or the Indo-Pacific theatres but accomplish tactical and strategic objectives.

Strategically, they demonstrate the Air Force's ability to operate with agility to the world. Tactically, they increase bomber force lethality, readiness, and experience across the force.

Planning and Execution

Each BTF mission is requested by a combatant command through USSTRATCOM to meet that command's individual need. According to Major General Mark Weatherington, Commander, Eighth Air Force the J-GSOC, is the operational arm of Air Force Global Strike Command, which is a crucial part of conducting bomber operations worldwide. J-GSOC and 608th Air Operations Center planners coordinate with USSTRATCOM and global combatant commands (GCCs) to develop objectives and tasks for specific Bomber Task Forces based on the National Defense Strategy and USSTRATCOM campaign plans.

Major General Mark Weatherington, Commander, Eighth Air Force. US Air Force

Maj Gen Weatherington said: "Once the overall strategy objectives have been devised, the 608th AOC and J-GSOC staffs develop detailed plans with GCC air component staffs and USSTRATCOM to maximise effects and integrate bomber sorties into GCC and USSTRATCOM campaigns. The execution plan is then handed to the 608th AOC and applicable geographic AOCs for execution."

Aerial refuelling is critical to the success of long-range, long-duration BTF missions, but all tanker aircraft are assigned to Air Mobility Command so are the KC-10 and KC-135 aircraft required for such a mission given priority tasking? General Weatherington confirmed that the success of the global BTF mission set is directly linked with the tanker support received from both US Transportation Command and the different geographic combatant commands. He said: "BTF missions generally have a high priority for tanker support, however, due to COVID concerns and other world events, the 608th AOC has to diligently work with our partners to ensure the successful execution of our BTF missions. The global demand for bombers and tankers is and will continue to be a 'heavy lift' to ensure tankers and

equipment are positioned correctly and have the necessary capacity for a full-range of possible mission sets. Bottom-line, we have a key partnership with the tanker and airlift force that fully enables our BTF operations."

Listing the organisations which are involved with arranging the inclusion of allied aircraft into BTF missions, General Weatherington said: "BTF mission execution is inextricably linked to tanker support, which takes an entire team effort. The 608th AOC's air mobility division coordinates with many different organisations to enable that support. Agencies include multiple geographic AOC air mobility divisions, Air Mobility Command's 618th AOC [the Tanker Airlift Control Center] and the GCC headquarters itself, to schedule support for US forces and international partners. This year [2020] we have been able to partner with several nations to ensure BTF mission execution and partner nation integration."

One important aspect of forward operating location (FOL) operations is mitigation of the unfamiliarity held by deployed personnel about the FOL, which might have limited support functions, and the requirement to adapt to a variety of potential real-world operational requirements. Acknowledging the vital need for such mitigation, General Weatherington said AFGSC relies on the training and teamwork of all who participate in order to mitigate FOL unfamiliarity. The Eighth Air Force commander said: "Aircrew, maintenance, operations support, security forces… the entire network of people working together -- all contributing to a common goal and objective. Professional airmen with the appropriate equipment and training enables AFGSC to be successful in any environment or location."

Under its BTF concept, AFGSC is now using new FOLs which requires various processes to be undertaken to determine a new operating location's suitability, as Weatherington explained: "A bomber site survey is typically performed to determine feasibility of a new location. Combatant commands, air components and site visit teams review any available survey information data to determine location feasibility. Follow-on data collection assesses infrastructure [runway length/width/pavement strength, parking areas, hangars, other maintenance facilities, and personnel billeting], fuel [types/quantities/availability, fuelling infrastructure], security, munitions storage, and other logistics support including delivery of spare parts, other items, and support equipment availability."

A B-1B Lancer assigned to the 345th Expeditionary Bomb Squadron after its arrival at Eielson Air Force Base, Alaska on September 10, 2020 in support of a Bomber Task Force mission. US Air Force/SMSgt Ted Daigle

Given a FOL has fewer people, resources, and aircraft to get the mission done, AFGSC must also determine what's required at the location to conduct flight operations. In general, BTFs are scalable and tailorable to the needs of the receiving combatant command. Requirements are based on mission objectives, the number of aircraft deploying, munitions requirements, and current support infrastructure and capabilities at that location. Ultimately, all items are negotiated between the supported and supporting commands.

In April 2020, AFGSC transitioned from retaining a Continuous Bomber Presence at Andersen Air Force Base, Guam to a new concept of operation that enables strategic bombers to operate in the Indo-Pacific theatre from more locations, when required, and with greater operational resilience, while the bombers are permanently based in the United States.

At the end of the Continuous Bomber Presence at Andersen, AFGSC reported that over a 15-month period, the two Bomb Squadrons assigned to the 5th Bomb Wing flew 1,022 sorties in four different areas of responsibility, amassing 6,100 hours of flight. What is amazing about this deployment is the fact that to

accomplish sustained ops and generate these numbers, the 5th Bomb Wing deployed with a standard maintenance support package.

When a new FOL is cleared for use by strategic bombers, a Contingency Response Group opens up the airfield and conducts initial aerial port operations to receive follow-on forces, such as the Expeditionary Bomb Squadron. If construction of infrastructure is required, the work will be done by Rapid Engineer Deployable Heavy Operations Repair Squadron Engineers, known as REDHORSE.

Once the basic infrastructure requirements of the airfield are established, the Expeditionary Bomb Squadron deploys to the FOL with its support package, ideally after conducting some form of site survey to identify gaps and limitations. A support package is designed to enable the squadron to generate combat sorties with minimal external support and is effectively self-contained. Other specific enablers such as air traffic control and fuel delivery are provided by the air component.

A Selection of BTF Missions

On August 28, 2020 six B-52H bombers flew over all 30 NATO nations in Europe and North America. The single-day operation called Allied Sky was intended to demonstrate NATO solidarity, enhance readiness, and provide training opportunities aimed at enhancing interoperability for all participating aircrews from the United States and NATO allies.

Allied Sky was conducted by four B-52s deployed to RAF Fairford which flew the European portion, and two B-52s assigned to the 5th Bomb Wing at Minot Air Force Base, North Dakota over Canada and the United States.

During its five-week BTF deployment to Fairford, the 5th Bomb Wing airmen conducted 57 missions with 100 allied aircraft from 30 different countries across Europe and Africa. Missions were flown over the North, Barents, Black, Norwegian, and Mediterranean Seas, and in the Baltic region.

On September 21, B-1Bs, B-2s and B-52H bombers collectively executed a long-planned BTF mission from Europe and the United States. The mission involved the bombers flying over multiple regions near the eastern-most portion of Europe and the western-most portion of the Pacific Ocean. Allied air forces participating in the mission were the Royal Air Force, Royal Canadian Air Force, and the Royal Norwegian Air Force.

B-1Bs assigned to Air Force Reserve Command's 345th Expeditionary Bomb Squadron conducted training with the Royal Norwegian Air Force on September 25, in a 16-hour sortie that crossed directly over the North Pole. The 6,100 nautical mile mission received air refuelling support over the Arctic Ocean before the aircraft spent several hours training with the Norwegian forces off the coast of Greenland and over the Norwegian Sea.

Approximately 200 airmen and four B-1B bombers assigned to the 9th Expeditionary Bomb Squadron based at Dyess Air Force Base, Texas, arrived at Andersen, Guam, on October 20, 2020 for BTF missions in support of Pacific Air Forces' training efforts with allies, partners, and joint forces.

Before arriving at Andersen, the B-1Bs flew with Japanese Self-Defense Force fighters comprising 16 F-15Js and two F-2s in the vicinity of the Sea of Japan and trained with the forward-deployed amphibious assault ship USS *America* (LHA 6) in the western Pacific Ocean.

Mark Ayton details two Air Force programmes applicable to the Beechcraft AT-6E Wolverine, Light Attack and Armed Overwatch.

WICHITA'S GUTSY LITTLE STRIKER

AT-6 demonstrator N620AT (c/n AT2) painted in the haze grey colour scheme loaded with two inert GBU-12 500lb Paveway II laser-guided bombs. All images Textron Aviation Defense

TEXTRON'S T-6 TEXAN II is a turboprop trainer aircraft at heart, but in its latest AT-6E guise it's a gutsy turboprop light attack aircraft. Air Combat Command has ordered two. The first, a former demonstrator aircraft, was delivered to the Air Force on December 15, 2020.

The second aircraft is on the production line at Textron's Wichita, Kansas facility. That aircraft will be delivered to the Air Force in December 2021.

Beechcraft AT-6E Wolverine

What exactly is an AT-6E? In short, it's an uprated T-6 Texan with 85% parts commonality customised for light attack. That customisation starts with a 1,600 horsepower-rated Pratt & Whitney PT6A-68D turboprop engine; the T-6 trainer's PT6 engine is rated at 1,100 horsepower. Night vision goggle-compatible cockpits feature Lockheed Martin's A-10C mission system and F-16 HOTAS-style flight control sticks, three multi-functional displays, the Scorpion helmet-mounted cueing system, an Esterline CMC 3000 flight management system, and Martin-Baker Mk16 0/0 ejection seats. Given its light attack role, it is no surprise that an AT-6E is fitted with plenty of self-protection equipment: armour around the engine, cockpit and fuel collector tank, missile warning and countermeasure systems, and a radar warning system. For a little turboprop aircraft, the AT-6E packs a comprehensive communications suite including two secure multi-band ARC-210 radios, a data and voice capable beyond line-of-sight Iridium satellite radio, a still image and full-motion video capable datalink. Designed to put weapons on targets, the aircraft is fitted with a Wescam MX-15Di EO/IR imaging system which offers all the capability requirements for that role; an infrared three-step zoom, colour daylight camera, and laser designator, illuminator, range finder and spot tracker.

Since the conclusion of the second light attack experiment in 2018, Textron upgraded the imaging system fitted to its AT-6 aircraft from the original MX-15 version to the digital MX-15Di. An almost certain improvement of the image resolution displayed in the cockpit which must be considered highly beneficial for its use in the light attack role.

Finally, kinetic effects, for which the AT-6E can carry a wide variety of weapons that include HMP-400 0.50-caliber guns, AGM-114 Hellfire laser-guided missiles, APKWS 2.75-inch laser-guided rockets, GBU-12 500lb Paveway II laser-guided bombs, and GBU-58 250lb Paveway II laser-guided bombs. Customer-specified weapons are easy to integrate on the AT-6E thanks to the aircraft's architecture.

Based on its experiences from providing close air support in Afghanistan and Iraq, the US Air Force has hankered after a light attack aircraft more affordable than fast jets.

Light Attack

According to the Congressional Research Service, on October 24, 2019 the Air Force issued a final request for proposals declaring its intent to acquire a new type of aircraft, more specifically the OA-X light attack aircraft, a small, two-seat turboprop aircraft designed for operation in relatively permissive environments. The announcement of a formal programme followed Air Force Light Attack Experiment I (July 2017) and Light Attack Experiment II (June 2018) to determine the utility of such an aircraft.

On several occasions during 2018, then Air Force Secretary Heather Wilson expressed the purpose of a new light attack aircraft as giving the Air Force an ability to free up more sophisticated and expensive assets for other tasks, citing the example of using high-end F-22 jets to destroy a drug laboratory in Afghanistan as an inefficient use of resources. Per-hour operating costs for light attack aircraft are typically about 2%-4% those of advanced fighters.

During LAE I and LAE II, the AT-6E Wolverine demonstrated its ability to conduct light attack, close air support, intelligence, surveillance and reconnaissance, forward air control airborne strike coordination, and experimentation with the Airborne Extensible Relay Over-Horizon Network, or AEROnet. The digital network links all friendly forces and provides their respective locations, and those of enemy forces, all in real-time.

AEROnet is an initiative conceived by former Air Force Chief of Staff General David Goldfein who wanted a system comprising off-the-shelf technology for use by nations fighting armed extremists that do not have access to NATO and US classified command and control systems.

It comprises airborne, ground and command and control nodes. An airborne node, such as an AT-6E, receives and relays data to and from other nodes.

In LAE II, an AT-6E flew with an early version of AEROnet comprising radios, antennas, tablets, and routers. But AEROnet does not denote a specific suite of systems, the future version will comprise different radios, antennas, tablets, and routers.

A ground node, comprising a hybrid tablet-satellite radio device, provides an operator such as a Joint Tactical Attack Controller, with airborne command and control capability. A command and control node provides commanders located at an operations centre with information from troops on the front line.

Textron's AT-6E Wolverine programme has evolved from the original concept of Light Attack to one that supports building ally and partner capacity, capability, and interoperability. A customer nation interested in AEROnet will be able to procure a pre-defined kit of radios, antennas, tablets, and routers.

Lift-off from a dirt strip during a light attack experiment. This image shows the aircraft loaded with four AGM-114 Hellfire laser-guided missiles and two rocket pods, each loaded with 2.75-inch rockets.

Armed Overwatch

US Special Operations Command (SOCOM) and Air Force Special Operations Command (AFSOC), launched Armed Overwatch in Q3 2020, an entirely independent programme to Light Attack, but one that Air Force acquisition chiefs believe 'piggy backs' Light Attack.

The initiative aims to procure up to 75 manned, fixed-wing aircraft over a five to 7-year period to address SOCOM's requirement for a close-air-support, Special Operations Forces intelligence, surveillance and reconnaissance, and precision strike capability. One with short take-off and landing capability which can operate in austere environments with minimal manning, infrastructure and sustainment.

The latter aspect is essential in support of Special Operations Forces engaged in low-intensity warfare at locations around Africa, Asia, and the Middle East. These are risky environments, where mission success and saving lives often depends on airborne fire support.

Right now, AFSOC does not own, let alone operate, a light turboprop aircraft to provide precision fires in support of small SOF teams fighting in the kinds of environments outlined above. AFSOC does own and operate a fleet of AC-130 gunships, but otherwise relies upon fire support provided by Air Force, Navy, Marine Corps or coalition fast jet types.

Given America's policy shift to counter future threats posed by China and Russia, the so-called great power competitors, resources relied upon in the past may be in demand elsewhere and therefore not available to support SOF units operating in austere locations elsewhere on the globe. To overcome any availability gap, SOCOM needs its own dedicated platforms capable of providing vital fire support.

Experiences endured in Afghanistan and Iraq helped define the requirements of the Armed Overwatch concept. Perhaps a pivotal moment for the concept happened at Tongo Tongo, Niger. On October 4, 2017 four American special ops troops and four Nigerien troops were tragically killed during an ambush by militants from the Islamic State in the Greater Sahara outside the village of Tongo Tongo.

The first aircraft to arrive on scene minutes after the US troops called for support, was an unarmed US drone. Armed support, Armee de l'Air Mirage 2000Ds, arrived on scene thirty minutes after receiving a call to respond. Unable to engage the militants due to a lack of positive identification, their presence overhead did bring the firefight to an end. This almost certainly saved the lives of the other American and Nigerien troops. Armed aircraft operating from a nearby airstrip might have saved lives lost that day. Perhaps the Tongo Tongo ambush serves as a test case for justifying an Armed Overwatch aircraft acquisition.

Aircraft types applicable to this mission set and available to AFSOC on the open market are the Leidos Bronco II, L3-Air Tractor Longsword, IOMAX Archangel,

The AT-6's forward, pilot cockpit features three multi-functional displays. AGM-114 Hellfire laser-guided missiles, APKWS 2.75-inch laser-guided rockets, GBU-12 500lb Paveway II laser-guided bombs, and GBU-58 250lb Paveway II laser-guided bombs.

Sierra Nevada Corporation-Embraer A-29B Super Tucano and the Textron AT-6E Wolverine.

Currently, SOCOM uses a fleet of 28 U-28A Draco aircraft for ISR missions in remote areas. In service since 2006, these Pilatus-built PC-12s are expected to reach the end of their service life limit within a couple of years. Under its current plan, SOCOM expects to replace its U-28s with the nascent Armed Overwatch aircraft.

Despite the urgency of procuring a replacement type, in July 2020 the future of the Armed Overwatch programme was uncertain. Senators have called on SOCOM leadership to conduct additional research and analysis to determine the way ahead for the programme.

The Senate Armed Services Committee said: "The committee is concerned that the rapid acquisition timeline being pursued by SOCOM does not allow for adequate consideration of: the cost of operating and sustaining the aircraft; the potential negative impacts on an already stressed community of pilots, aircrews, and maintainers; and how such a costly addition fits into SOCOM's medium-to-long-term airborne intelligence, surveillance, and reconnaissance capability roadmap."

Research and analysis is currently ongoing until the early part of 2021, and pending the results, may lead to a prototype demonstration in the summer.

The Future

Following LAE II in early 2019, the Air Force announced it would not go ahead with a programme of record for a light attack aircraft. Instead, the Air Force has procured three A-29Bs for AFSOC and two AT-6Es for Air Combat Command. The three A-29Bs will be used for the Combat Aviation Advisor mission, one designed to help build international partner capacity. AFSOC will receive all three aircraft in 2021. Training and support activities will continue through 2024.

Once the first Air Force AT-6E aircraft is delivered to the service, the Light Attack Aircraft Program Office will work with Textron Aviation Defense,, to obtain airworthiness certification for the AT-6E during the first six months of 2021.

After completing certification, Textron Aviation Defense will train Air Force instructor pilots assigned to the 81st Fighter Squadron based at Moody Air Force Base, Georgia, in preparation for the Continued Light Attack Experiment or CLAE. This effort will be focussed on the development and use of AEROnet, which is expected to take place between January and May 2022. According to the Light Attack Aircraft Program Office, the CLAE's objective is to explore cost effective solutions for countering violent extremist organizations by co-developing and implementing tactics, techniques, and procedures with partner nations, utilising a light attack aircraft. This includes development of operational tactics and standards for exportable, tactical networks that improve interoperability with international partners. This effort will also examine ways to build partner nation light attack capacity to enable those nations to conduct security operations independently or in partnership with the United States.

For Textron, the sale of the AT-6Es to the Air Force and its entry into the inventory will result in full military type certification of the aircraft. Whilst military type certification is not an official endorsement of the aircraft, it acts as a stamp of approval which is critical for selling the aircraft to export customers. Textron is actively marketing the AT-6 to air arms around the world, a type that's likely to appeal to nations that already operate the T-6 trainer. As a low-cost, light attack aircraft, nations such as Argentina, Iraq, Mexico, Morocco, and Tunisia might well be interested.

But Beechcraft's chance opportunities to sell the AT-6 are not limited to export customers. Packing a 1,600 horsepower PT6 engine, plenty of advanced systems, and an arsenal of weapons, Textron's gutsy Wolverine is entirely suitable for SOCOM's Armed Overwatch requirement. There can be no doubt how happy Textron's AT-6 programme personnel would be with an award for 75-plus aircraft.

In this image, note how the two HMP-400 0.50-calibre guns are loaded on the inner station of AT-6 demonstrator N610AT (c/n AT1).

An AT-6 kicks up dirt and dust on an austere landing strip loaded with two HMP-400 0.50-calibre guns (on each outboard station), two GBU-12 500lb Paveway II laser-guided bombs, and two external fuel tanks.

EAGLE WING

Mark Ayton details C-5 and C-17 operations with the 436th Airlift Wing.

DOVER AIR FORCE Base is located in Kent County, Delaware, the 'First State' and home to the Department of Defense's largest aerial port and nearly 9,000 airmen and joint service members, civilians, and families. Its personnel are responsible for global airlift aboard C-5M Super Galaxy (by the 9th Airlift Squadron) and C-17 Globemaster III (by the 3rd Airlift Squadron) aircraft assigned to the resident 436th Airlift Wing.

Additionally, the 436th hosts key partners, such as the Air Force Reserve's 512th Airlift Wing, Air Force Mortuary Affairs Operations (AFMAO), the Armed Forces Medical Examiner System (AFMES) and the Joint Personal Effects Depot (JPED), jointly responsible for the dignified return of fallen American service members.

Known as the Eagle Wing, the 436th comprises more than 4,000 active-duty airmen and answers to the 18th Air Force and Air Mobility Command, both located at Scott Air Force Base, Illinois.

One of the wing's most significant component units is the 436th Aerial Port Squadron known as the 'Super Port'. Its primary mission is to facilitate movement of cargo, mail, and passengers to support operations directed by the President of the United States, the Department of Defense or the Joint Chiefs of Staff, and United Nations peacekeeping efforts worldwide.

The 512th Airlift Wing, also known as Liberty Wing, is an Air Force Reserve unit assigned to Dover Air Force Base and assists with maintenance and operation of the C-5M (by the 709th Airlift Squadron) and C-17 (by the 326th Airlift Squadron) aircraft assigned to the 436th AW.

Combined, the two wings fly hundreds of missions throughout the world, providing movement of outsized and oversized cargo in addition to personnel on scheduled, special assignment, exercise, and contingency airlift missions. Together, they account for 20% of the nation's strategic outsized airlift capability, projecting global reach to more than 100 countries.

Air Force Mortuary Affairs Operations (AFMAO) is charged with fulfilling the

Above: **A 436th Airlift Wing C-17A Globemaster III expends countermeasure flares over the Bollen live-fire range complex at Fort Indiantown Gap, Pennsylvania.** US Air Force/ Greg Davis

nation's sacred commitment of ensuring dignity, honour, and respect to the fallen and care, service, and support to their families. A solemn dignified transfer of remains is conducted upon arrival at Dover from the aircraft to a transfer vehicle to honour those who have given their lives in the service of the country. The vehicle then moves the fallen to the Port Mortuary at the Charles C. Carson Center for Mortuary Affairs. Once positively identified, fallen service members are prepared for transport to their final destination as determined by the family.

Armed Forces Medical Examiner System (AFMES) provides the DoD and other federal agencies comprehensive forensic investigative services, to include forensic pathology, DNA forensics, forensic toxicology, and medical mortality surveillance. AFMES is not only the single worldwide medical examiner system, but it also supports the entire US federal government.

Joint Personal Effects Depot (JPED) provides care and support to families and loved ones attending dignified transfers and processes all personal effects of service members from all branches, as well as DoD civilians and contractors killed within theatre operations. The only organization of its kind in the DoD, JPED pioneered and advanced the care and handling of personal effects to ensure they are delivered to the person eligible to receive effects in a presentable and timely manner.

Together these units are referred to as Team Dover due to their cooperative mission requirements.

C-5M Super Galaxy

The C-5M Super Galaxy is a modernised version of the legacy C-5 strategic transport aircraft designed and manufactured by Lockheed Martin. It is the largest aircraft in the US Air Force inventory with a 100ft long, 17ft 2in wide and 13ft 6in high cargo compartment with front and rear access doors. Its primary mission is transportation of cargo and personnel for the Department of Defense.

Thanks to the front and rear access doors, load teams can simultaneously load and offload cargo from both ends, reducing transfer times. Full-width drive-on ramps at each end enable double rows of vehicles to be transported. The C-5 fleet is planned to retire in the 2040-time frame and will be recapitalized by the winner of the nascent C-X programme.

C-17 Globemaster III

Reckoned to be the most flexible cargo aircraft to enter the airlift force, the C-17 is capable of rapid delivery of troops and all types of cargo to main operating bases or directly to forward bases in a deployment area. The aircraft can perform tactical airlift and airdrop missions and can transport litters of ambulatory patients during aeromedical evacuations.

Channel Missions

Air Mobility Command's most numerous and routine type of mission is the channel mission. These are regularly flown from Dover by C-5M Galaxy and C-17A Globemaster III aircraft. The process for launching a channel mission starts with a set of validated mission requirements submitted to the 618th Air Operations Centre (AOC) by US Transportation Command. Both organisations are based at Scott Air Force Base, Illinois.

For the purposes of this publication, we'll use two examples of channels flown from Dover. A C-17A loaded with palletised cargo bound for RAF Mildenhall, England and a C-5M carrying AH-64 Apache helicopters to Ramstein Air Base, Germany.

A component unit known as the 436th Current Operations receives the tasking from the AOC, then assigns each mission to a flying squadron, which assigns a crew, based on availability. All pertinent information is then relayed to the 436th Aircraft Maintenance Squadron, which assigns an aircraft to the mission.

Various sections in the 436th Aerial Port Squadron are involved. Each one has a direct impact on the missions to Mildenhall and Ramstein. For example, the fleet services section services every aircraft lavatory and delivers meals and

Airmen push a C-5M Super Galaxy aircraft assigned to the 436th Airlift Wing into position for refuelling at Camp Marmal, Afghanistan. US Air Force/ TSgt Parker Gyokeres

expendables (such as earplugs, cups, water coolers and airsickness bags) to the assigned aircraft. Cargo is processed by the air terminal operations centre and handled by the air freight section.

Explaining the procedures of transporting AH-64 Apache attack helicopters to Ramstein loaded on a C-5M, Colonel Mike Peeler, 436th Operations Group commander said: "Load planning is extremely important as you consider putting hundreds of thousands of pounds of cargo onto a delicately balanced aircraft. Even the monstrous C-5M requires precision weight and balance to keep the aircraft aloft. Though the load plan will be checked by several people before final approval, it is the aircraft loadmaster who has final authority over the loading. In this case, the loadmaster will work with the Army loading team at the aircraft to ensure requirements are met. This, of course, is the last step of a multi-layered process to ensure, in this case AH-64s, get to their destination at the right time, in the right sequence."

In the case of the C-17 mission, the 618th AOC coordinates with the 436th Airlift Wing, whose C-17 loadmasters ensure the palletized cargo meets exacting specifications prior to loading.

Once that's all set-up, the aircrew is given a briefing about their forthcoming mission several days or weeks prior to departure.

Discussing aspects of aircrew allocation, Col Peeler said: "Flexibility is a key tenet to success of the air mobility enterprise. C-5s and C-17s can be tasked dynamically (sometimes while in flight) to take on a last-minute, higher-priority mission. For this reason, we provide our aircrews with the latest tools to make them worldwide-capable at a moment's notice."

The ramp services section loads all aircraft at Dover Air Force Base, in concert with loadmasters and joint and total force partners – including other military branches, the Air Force Reserve and the Air National Guard. Once en route, the mission loadmasters are responsible for loading and unloading cargo, with assistance from a local load team, such as one provided by the US Army.

Having flown to Mildenhall and Germany respectively, aircrews are authorized at least 17 hours of crew rest for food and sleep.

According to the 436th AW it is standard practice for the crew to stay with the same aircraft until they return to home-station.

At the beginning of this section we used the terms outsized and oversized cargo. Outsized cargo is defined as cargo that won't fit on a single aircraft pallet. Oversized cargo is cargo that, due to its size and dimensions, requires marrying together multiple pallets for loading. Examples include large, rolling stock items such as tanks and helicopters, or any type of load that requires special tie-down and centre-of-balance markings.

Due to operational security concerns, the 436th AW was unable to provide any details regarding support capabilities for presidential support missions.

However, asked what a duty day looks like on such a mission, Captain Stephen Dillon, a 3rd Airlift Squadron C-17A pilot and scheduler, who was on a previous presidential support mission to England said: "Usually it's a 16-hour duty day that involved travelling to the departure base to load the cargo, then the ocean crossing to the UK, though we didn't continue on to other locations."

C-17 crews are generally notified at least a week prior to departure on a presidential support mission. Cargo may consist of vehicles, helicopters and support personnel all loaded by a combination of C-17 loadmasters and owners of the cargo.

Combat Readiness

Explaining how the 436th Operations Group maintains combat readiness of its squadrons, Col Peeler said: "Both the 3rd and the 9th Airlift Squadrons maintain combat readiness through deliberate training models. Today's mobility operators have to be proficient in both congested and contested environments. A congested environment is what we might consider over the Eastern United States, where a growing number of aircraft occupy a finite space, separated by deliberate procedures and advanced traffic surveillance systems. This requires our pilots to be proficient in, and good stewards of, the international airspace system. The ability to operate in a contested environment is what sets Air Force operators apart from commercial pilots; this combat readiness is achieved through scalable scenarios and training with other mission partners. We participate in multiple exercises, both large and small, to hone the skills required in a contested environment."

The 57th Weapons Squadron based at McChord Air Force Base, Washington is the C-17 Weapons School schoolhouse.

Below: **A ramp supervisor assigned to the 436th Aerial Port Squadron, marshals a Humvee down the forward loading ramp of a C-5M Super Galaxy at Dover Air Force Base, Delaware.** US Air Force/ Roland Balik

Right: **A C-5M Super Galaxy taxis down the flight line prior to an early evening take-off at Dover Air Force Base. The aircraft is one of 18 assigned to Dover Air Force Base.** US Air Force/ Roland Balik

Asked how the 3rd Airlift Squadron works with the 57th in support of its weapon instructors and what aspects of C-17 operations the new weapons instructors impart on the squadron, Lieutenant Colonel Zane Hershey, 3rd Airlift Squadron commander and weapons officer said: "We try to highlight folks who are interested and who have the aptitude and attitude [to attend the school]. We try to highlight them early. I'm going to be biased, but the C-17 weapons course is the toughest course in AMC. There isn't even a close second. It's primarily a planning and leadership course. Flying is a third priority of the course overall. We work with other units and undertake off-station training to improve the quality of operations. It just so happens that our Operations Group executive officer is a weapons officer. They are the ops 9-1-1 call. We use them to plan combat sorties. They're on the hook to help if contingency operations arise. Based on the timing of assignments, the pilots we send to weapons school often leave soon after. So, we're building weapons officers for someone else in the hope we get one. I'm preparing the squadron to perform on our worst day, which involves heavy integration with off-board assets. Our worst day looks like, 'I don't know where I'm landing when I take off.' Those are the things I'm on the hook to make sure the squadron can do."

Rating the Super Galaxy

Given the accumulated years of operating F138 engine-powered C-5Ms, when asked how the 9th Airlift Squadron rates the General Electric F138 engines in terms of performance and reliability, Lieutenant Colonel Andrew Stein, 9th Airlift Squadron director of operations said: "The new engines are extremely capable. They allow the C-5M to take off with greater payloads, climbing to altitude more quickly, which results in a more fuel-efficient flight. The engines are also very reliable. Our maintenance counterparts will have specific data, but anecdotally, they have had very few issues."

Lockheed Martin originally sold the C-5M as an upgraded aircraft with shorter take-off, higher climb rate to initial altitude, increased cargo load, and longer range performance. Lt Col Stein confirmed that all of the performance aspects are accurate. He said: "The new M-model allows us to depart locations at max operating weights and fly direct to destinations we would not have been able to reach in previous models without a fuel stop or aerial refuelling. This capability saves time and money and allows for greater flexibility in mission planning as well as increased cargo throughput at our ports. This also allows us to operate at challenging fields [short runways] in challenging environmental conditions [high temperatures and pressure altitudes] with greater cargo payloads then previously possible."

To date, none of the 436th's assigned C-5Ms equipped with F138 engines have yet reached the 10,000-hour on wing major service requirement.

Since the C-5M's four-month operational evaluation involving war supplies from Dover to Incirlik, Turkey, and the

Aircrew assigned to Air Force Reserve Command's 326th Airlift Squadron, on the flight deck of a C-17A Globemaster III during aerial refuelling from a KC-135R Stratotanker assigned to the 171st Air Refueling Wing, Pennsylvania Air National Guard. US Air Force/ Greg Davis

unprecedented on-time and surge performance achieved, flight hours and fuel saved, has the 9th Airlift Squadron achieved similar performance metrics on operational missions? A 436th AW spokesperson gave the following answer: "The 9th Airlift Squadron provides global reach with unique outsized and oversized airlift capability. The unit supports global engagement through direct delivery of time-critical theatre deployment assets and ensures combat readiness of AMC active-duty C-5 airlift crews."

Furthermore, has the additional capability of the C-5M helped in offsetting the heavy use of C-17s? AMC public affairs provided this answer: "The C-5M and C-17 together comprise our strategic airlift fleet, which together allow us to project decisive strength and deliver hope, sustainability and lethality to the right place at the right time ... always! The C-5 fleet of 52 aircraft provides unmatched airlift capability as the largest aircraft in the Air Force inventory, and its primary mission is to airlift combat forces, equipment, and supplies. Our 222-strong C-17 fleet combines tactical capability with strategic range and is capable of rapid strategic delivery of troops and all types of cargo to main operating bases or agile combat employment directly to austere airfield environments."

Saving Money

According to the 436th AW's public affairs office the 436th Aerial Port Squadron saved approximately $5 million through collaborative efforts with the 618th AOC to reroute and resource cargo missions through the installation despite complication faced because of the COVID-19 pandemic.

According to Bradley Schmidt, 436th APS cargo scheduler: "In some instances, [before COVID] an aircraft used to come in and spend 24-48 hours [on the flight line] before it took off to go back home. They're now spending two or three hours here: just enough time for us to get cargo off, new cargo on, and then they go to their next location."

The combination of COVID-19 procedures and limited time for ground operations required the APS to collaborate and devise a new and more efficient way to plan and execute mobility missions on a combination of both military and commercial aircraft.

Capability forecasters tasked with maximizing aircraft utilization and ensuring that logistics run smoothly work with the 618th AOC's channel requirement branch, to coordinate conflict-free cargo missions.

Destiny Donigan, 436th APS cargo scheduling supervisor and capability forecaster, recognized how many C-5Ms and C-17As were leaving Dover towards cargo destinations empty.

Through coordination with the 618th AOC's channel requirement branch, Donigan and her team managed to get missions re-routed via Dover. This permitted cargo to be moved on Dover-based C-5s and C-17s rather than using commercial flights that cost a significant amount of money. The cargo was then allowed to enter the local port and permitted shared space utilisation on scheduled airlifts. Re-routing gets the cargo to destinations on time, if not ahead of schedule.

Brigadier General Daniel DeVoe, 618th Air Operations Center commander said: "Through our strategic partnership with the 436th APS and our recent transformation, the 618th AOC applied innovative solutions, delivered cargo faster and saved the taxpayer nearly $5 million."

Left: **Sunset at Dover Air Force Base, Delaware.** US Air Force/ Senior Airman Christopher Quail

Below: **C-5M Super Galaxy 87-0035 taxis from the gargantuan flight line at Dover Air Force Base.** US Air Force/Greg Davis

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© 2018 Textron Aviation Inc. All rights reserved. The sale and export of the AT-6 aircraft as well as the associated maintenance support and any unique technical data will require USG export license approval under the International Traffic in Arms Regulations (22 CFR Parts 120–130) or the Export Administration Regulations (15 CFR Parts 730–774).

FOLLOWING GIANT FOOTSTEPS

Tom Kaminski details the brand new HH-60W helicopter recently delivered to the US Air Force.

TEST PILOTS AND engineers in Florida and Connecticut are conducting evaluations that will support the fielding of the first new Combat Search and Rescue (CSAR) helicopter to enter US Air Force service in nearly 30 years. Known as the Jolly Green II, the HH-60W will provide personnel recovery (PR) forces with a vertical take-off and landing aircraft that is quickly deployable and capable of main base and austere location operations in support of worldwide missions.

The CSAR and PR missions involve the extrication of isolated personnel from hostile or denied territory. The low-profile, yet politically important mission, is one of the most challenging faced by US military forces. It is a highly-specialized mission that is carried out by dedicated rescue or special operations forces (SOF) personnel. PR is one of the US Air Force's 12 core functions and the service is the world leader in the role. In coordination with the other military services, the US Air Force conducts global PR operations including theatre-wide CSAR, PR and civil search and rescue (SAR). Its forces comprise specially-configured aircraft, trained aircrews and pararescue personnel.

The ability to recover downed aircrew was deemed to be so important that commencement of air operations over Afghanistan in support of Operation Enduring Freedom were delayed until an operating base was established in Uzbekistan.

In preparation for Operation Iraqi Freedom the country was divided into CSAR sectors and specific assets were assigned to each. CSAR forces were positioned as close to the front lines as possible and assigned to forward operating locations (FOL) within Iraq as soon as ground forces secured them.

On June 26, 2014, the US Air Force awarded Sikorsky Aircraft and Lockheed Martin an initial $1.28 billion contract to design and build a new Combat Rescue Helicopter (CRH). Based on the US Army's UH-60M Black Hawk airframe, the new personnel recovery aircraft was referred to

HH-60W Jolly Green II 14-4480 (c/n EDM 1) connects with an HC-130J tanker for its first aerial refuelling over southern Alabama on August 5, 2020. US Air Force/ MSgt Tristan McIntire

as the CRH-60 until November 29, 2014 when the then Secretary of Air Force, Deborah Lee James announced the assignment of the designation HH-60W. The engineering, manufacturing, and development contract (EMD) included four helicopters, but the Defense Acquisition Executive (DAE) approved the acquisition programme baseline (APB) of 112 aircraft earlier on June 18, 2014.

Development

The CRH programme was initiated as the HH-60 Recapitalization (RECAP) programme following approval on March 2, 2012, by the then Undersecretary of Defense for Acquisition, Technology and Logistics, Frank Kendall.

Release to industry of the request for proposals (RFP) for the renamed CRH programme followed in October 2012. The Sikorsky-Lockheed Martin team became the only bidder for the project in December 2012, after Boeing, EADS North America and a team comprising Northrop Grumman and AgustaWestland all elected not to respond to the RFP.

The programme is managed by the Rotary Wing Branch of the Air Force Life Cycle Management Center's Special Operation Forces/Personnel Recovery Division at Wright-Patterson Air Force Base, Ohio.

Prior to issuing the CRH contract, the US Air Force made several failed attempts at procuring new helicopters for its combat rescue forces. On November 10, 2006, the then Secretary of the Air Force, Donald Rumsfeld announced that Boeing's HH-47 would become the service's new Combat Search and Rescue Replacement Vehicle, which was known as CSAR-X. As part of the $10 billion programme Boeing was expected to build four test and 141 production aircraft based on the MH-47G version of the US Army's Chinook.

Above: **HH-60W Jolly Green II 14-4481 (c/n EDM 2) sits under bright lights used to create heat in the McKinley Climatic Lab at Eglin Air Force Base, Florida. The Air Force's new helicopter and crews experienced temperature extremes from 120F to -60F, and torrential rain during a month of testing. Climatic tests evaluate how the aircraft and its instrumentation, electronics, and crew fare under the extreme conditions it will face during operations.** US Air Force/Samuel King Jr

A stop-work order was issued to Boeing shortly after Lockheed Martin and Sikorsky filed protests against the award and in February 2007, the protests were upheld by the Government Accountability Office (GAO). Although the US Air Force made several attempts to restart the CSAR-X, in June 2009 the programme was formally terminated under direction from the Office of Secretary of Defense, which also directed the US Air Force to acquire replacement rotary-wing vehicles based upon "currently fielded CSAR capabilities."

Later, in March 2010, the US Air Force released a Capability Request for Information associated with a plan to acquire modified Black Hawks under the HH-60 Recapitalization programme. The effort included the directed purchase of US Army HH-60Ms with modifications to support the CSAR role. After additional false starts, the restructured programme morphed into the HH-60 RECAP and finally the CRH programme. Politically-charged, the programme finally got moving when the CRH was designated as a congressional special interest item and $333.5 million was allocated to the programme in FY2014.

Sikorsky and the US Air Force completed the CRH Program Air Vehicle preliminary design review in April 2016. The critical design review followed in May 2017, and paved the way for Sikorsky to begin assembly, test, and evaluation of the EMD helicopters.

In January 2017, the US Air Force exercised a $203.4 million contract option with Sikorsky for five system demonstration test aircraft (SDTA) that were built to production standard. A tenth development helicopter was funded in FY2020. Referred to as a modernization development aircraft, it will support the test and evaluation of new systems planned for the HH-60W. Because the basic configuration of the CRH was set in 2012, a number of improvements are already being considered for incorporation under a planned capability upgrades programme. These include a video data-link, the directed infrared countermeasures (DIRCM) system, anti-jam GPS system and a degraded visual environmental system (DVES). Sierra Nevada Corporation is developing the DVES under a contract awarded in June 2019.

Below: **HH-60W Jolly Green II 14-4481 (c/n EDM 2) sits in the frozen chamber of the McKinley Climatic Lab at**

HH-60W

The new helicopters will replace the survivors of the 112-strong HH-60G fleet that entered service between 1991 and 1997. Sikorsky Aircraft modified 35 UH-60A and 77 UH-60L airframes to CSAR configuration at its Troy, Alabama, facility. Initially delivered under the designation MH-60G, most Pave Hawks received the designation HH-60G following their transfer from Air Force Special Operations Command (AFSOC) to Air Combat Command (ACC) in 1991.

A small number of MH-60Gs were retained by AFSOC until late 1998 when they were finally reassigned to ACC. The 94 surviving HH-60Gs comprise 12 assigned to training duties, 81 operational aircraft as well as two that support test & evaluation activities. Since 2001 alone, mishaps have caused at least nine HH-60Gs to be written off.

Like its predecessor, CSAR/PR will be the HH-60W's primary mission, however, collateral duties will include humanitarian missions, civil SAR, disaster relief, casualty, and medical evacuation (CASEVAC and MEDEVAC), and non-combatant evacuation operations.

The helicopter is expected to operate day/night in adverse weather under a variety of threat environments that include terror attacks, chemical, biological, radiological, and nuclear.

Its aircraft survivability equipment (ASE) suite includes the BAE Systems AAR-57(V)3 common missile warning system and ALE-47 countermeasures dispenser set that features six integrated chaff/flare dispensers, Collins Aerospace AVR-2B(V)1 laser detection set, and Lockheed Martin's APR-52(V)1 digital radar warning receiver. The HH-60W also features an upturned exhaust system, designed to reduce the helicopter's infrared signature, and lightweight cabin and cockpit floor and wall armour protection. Externally-mounted, crew-served defensive weapons comprise the six-barrel 7.62mm GAU-2 mini-gun, legacy 0.50 calibre GAU-18 and GAU-21 machine guns. The mounting systems permit the weapons to be locked in a fixed forward firing position.

The HH-60W has a maximum gross take-off weight of 22,500lb, is capable of hot and high-altitude performance and will be capable of hovering out-of-ground effect at an altitude of 4,000ft in temperatures up to 95°F, while operating at its mid-mission gross weight. Also, thanks to a 660-gallon internal fuel cell, it will have a greater range than its predecessor.

Although it is equipped with a retractable aerial refuelling boom and a fuel dump system, the helicopter is designed to fly a combat radius of 195nm without refuelling. The design of the internal fuel tank also frees up additional cabin space compared to the HH-60G. Its versatile main cabin has been optimized for the CSAR/PR mission but can be adapted for a variety of tasks. The cabin's rescue configurations support improved patient care and offer maximum flexibility. An external 600lb capacity rescue hoist is also provided.

The HH-60W shares many features with the US Army's UH-60M helicopter, including its General Electric T700-GE-701D engines, composite wide-chord main rotor blades, and fatigue- and corrosion-resistant machined aero-structures. Additionally, it retains the UH-60M's 9,000lb capacity cargo hook.

Its advanced systems include the Link 16 situational awareness data link, integrated broadcast receiver, and blue forces tracker. The HH-60W's integrated flight and mission display system is based on the UH-60M's common avionics architecture system. Four integrated multi-function displays are provided in the cockpit and three are located in the cabin. Lockheed Martin, which purchased Sikorsky Aircraft from United Technologies in 2015, developed the helicopter's tactical mission kit that integrates the communications, mission computers, sensors, defensive and mission planning systems with the HH-60W.

HH-60W 14-4483 (c/n EDM 4) was the first of two assigned to the 413th Flight Test Squadron based at Duke Field, Florida. Note the upturned engine exhaust system and the huge fairing on the forward fuselage housing some of the aircraft's sensors. US Air Force/Samuel King Jr

Production

Sikorsky is producing HH-60W airframes at its Stratford, Connecticut facility and final assembly of the first EMD HH-60W began there in February 2018. The second EMD aircraft was the first to fly at the contractor's Developmental Flight Center in Jupiter, Florida, on May 13, 2019. The initial flight of the number one HH-60W occurred later on May 23. A formal roll-out ceremony took place at the DFC on October 9, 2019 and the first of the helicopters arrived at Eglin Air Force Base's Duke Field on November 6, 2019. Testing at the Florida facility is being carried out by an integrated test team comprising personnel from the Air Force Material Command's 413th Flight Test Squadron, Detachment 2, of Air Combat Command's 88th Test and Evaluation Squadron, Sikorsky and the Air Force Operational Test and Evaluation Center.

Thus far, ten air vehicles were procured during EMD, with 22 following under the first two of four planned low rate initial production (LRIP) lots that will provide up to 61 HH-60Ws. The programme is expected to move into full rate production (FRP) in Lots 5 and 6. The service currently plans to spend around $9 billion to acquire 108 HH-60Ws through FY2024. It has not allocated funding for the final five helicopters.

The first pair of HH-60Ws was delivered to the 347th Rescue Group's 41st Rescue Squadron at Moody Air Force Base, Georgia, on November 5, 2020. The 58th Special Operations Wing's 512th Rescue Squadron will be responsible for standing up training operations at Kirtland Air Force Base, New Mexico. The HH-60W will achieve initial operational capability (IOC) in 2022 and fielding to all active-duty

squadrons will follow. Air Force Reserve Command and Air National Guard units will transition to the HH-60W beginning in FY2026 and FY2027, respectively.

The US Air Force received a Milestone C decision that permitted the HH-60W to enter into LRIP on September 24, 2019. Sikorsky was then awarded a $564 million contract for the Lot 1 batch of ten HH-60Ws. Sikorsky received a second HH-60W LRIP contract in February 2020. Valued at $500 million it funded 12 additional helicopters. The program of record was increased to 113 HH-60Ws when the modernization flight test aircraft was added, and the revised APB was approved on September 24, 2019. Purchase of the aircraft, using research and development funds, was approved as part of the FY2020 defence authorization. The US Air Force's FY2021 base and overseas contingency operations' budgets respectively provided funding for 16 and three helicopters, respectively. Deliveries of the first 10 LRIP aircraft will begin in 2021 and the programme is expected to enter FRP in FY2023.

Above and right: **Four HH-60W test aircraft (c/n EDM 1 to EDM 4) during a photo flight at Sikorsky's Developmental Flight Center in Jupiter, Florida.** Sikorsky

Left: **HH-60W Jolly Green II 14-4488 taxis at Moody Air Force Base, Georgia on November 5, 2020, delivery day of the 41st Rescue Squadron's first two aircraft.** US Air Force/Andrea Jenkins

Testing

Development testing associated with the EMD programme began in September 2018 and was expected to be completed by December 2020. Since first flight, the programme has made considerable progress. The third EMD helicopter supported seven weeks of defensive systems testing in the 96th Test Wing's Joint Pre-flight Integration of Munitions and Electronic Systems (J-PRIMES) anechoic chamber at Eglin Air Force Base, Florida, beginning in November 2019. The second helicopter underwent a month of extreme weather testing in the wing's McKinley Climatic Laboratory co-located at Eglin, that concluded on April 2, 2020. Carried out in the 55,000ft^2 test chamber, the climatic tests subjected the aircraft to temperatures ranging from -60°F to 120°F, torrential rain, and 45mph winds.

Referred to as Whiskey 1, the first EMD HH-60W supported live-fire ground testing of the Jolly Green II's primary weapons at Eglin, over a three-week period beginning August 17, 2020. The helicopter's crew-served GAU-2, GAU-18 and GAU-21 weapons respectively deliver rates of fire of 3,000, 650-800 and 950-1,100 rounds per minute. Their ability to rotate independently, providing an almost 360° firing arc surrounding the aircraft.

Conducted by the 413th Flight Test Squadron, the ground tests were intended to verify the functionality and accuracy of the weapons and to confirm they are safe for operational employment.

Whiskey 1 is equipped with flight test instrumentation that monitors hundreds of parameters during envelope expansion testing. The specialized instrumentation also recorded the stress and strains placed on the aircraft by firing the weapons. Data from the ground testing phase will be evaluated by engineers from the Air Force's Non-Nuclear Munitions Safety Board before clearance for in-flight live fire flight testing that was expected to be approved and begin in late 2020.

Whiskey 1 also conducted the helicopter's first aerial refuelling when it connected with a US Air Force HC-130J Combat King II on August 5. The initial refuelling took place at an altitude of 3,000ft and a speed of 110kts over the Eglin range. The mission, flown by a joint US Air Force-Sikorsky crew, marked the start of a two-week period of aerial refuelling development test schedule. Initial tests were flown in daylight, but the schedule concluded with a night mission conducted with night-vision goggles.

In addition to these milestones, the programme successfully completed several other ground evaluations including structural loads and infrared signature testing. Meanwhile, testing of the defensive system, cybersecurity, mission systems, and avionics is continuing. Additionally, the final planned major software upgrade, associated with the development programme, was completed in June 2020. Further testing will involve software regression, avionics certification, weapons, and final updates to the defensive systems.

When FY2020 came to an end on September 30, the CRH programme comprising nine aircraft, four EMD and five SDTA models, had logged over 800 flight hours. Additionally, major assembly of Lot 1 LRIP helicopters had started.

Initial operational test and evaluation is currently scheduled to begin in spring 2021 at Moody Air Force Base, Georgia. Largely as a result of delays in the start of flight testing, the HH-60W's required assets available (RAA) milestone has shifted from March 2020 to mid-2021 with IOC following in the autumn. The RAA milestone requires the delivery of eight production configured helicopters with four assigned to training and four to operational duties. Delayed due to the worldwide COVID-19 pandemic, LRIP deliveries are now expected to begin in May 2021.

Secretary of the Air Force, Mark Esper revealed selection of the popular name 'Jolly Green II' for the HH-60W during the Air Force Association's Air Warfare Symposium on February 27, 2020. The name was chosen to honour distinguished service provided by the Vietnam-era HH-3E and HH-53-series helicopters. Often referred to as Jolly Green Giants, the aircraft pioneered the rotary wing CSAR mission during operations in Southeast Asia. Following in the footsteps of its predecessors, the Jolly Green II will carry on the legacy started by the HH-3 and the HH-53, and refined by the HH-60G to ensure 'That Others May Live', the motto of US Air Force pararescue men and their commitment to saving lives and self-sacrifice.

B-2 SPIRIT: STEALTH BOMBER

David Isby details America's billion-dollar bomber.

NORTHROP GRUMMAN'S BLOCK 30 B-2 Spirit stealth bomber is like no other aircraft. A tailless flying wing, its design offers both low observable stealth and high aerodynamic efficiency. It is designed for long-range missions carrying munition payloads of up to 60,000lb which are carried in two weapons bays housed within its blended fuselage and wing.

Combat employment requires the stealth bomber to strike high-value targets anywhere in the world, and return to Whiteman Air Force Base, Missouri, or recover to specific forward operating locations.

The B-2 force is normally maintained at readiness as America's silver bullet, able to penetrate hostile airspace against the highest value targets, where it can accurately deliver conventional or, if required, nuclear weapons.

It is the only penetrating bomber armed with nuclear gravity bombs and will continue to be so until its replacement by a new stealth bomber, the Northrop Grumman B-21 Raider in the early 2030s.

Current Fleet, Current Configuration

Based at Whiteman Air Force Base, Missouri, the B-2 equips the active-duty 509th Bomb Wing and Missouri Air National Guard's associated 131st Bomb Wing. Despite having made its first flight over 30 years ago on July 17, 1989, and with an average airframe age of 25 years, it remains America's most advanced strategic bomber. It incorporates older, second-generation stealth technology, which is less effective, and more significantly, imposes higher sustainment costs than those of more recent stealth aircraft such as the F-22 Raptor and F-35A Lightning II. According to FY2012 figures, a B-2 costs $122,000 per-hour flight. In recent years, B-2 pilots – over 100 are based at Whiteman – normally fly the majority of their time in a simulator, and 100 hours per year in real aircraft.

Contributing to the $122,000 per-hour flight operational cost is the small size of the B-2 force, and the difficulty of sourcing needed parts from the industrial base. In 2019, the B-2 fleet sustained an average 60% mission capable rate.

This image shows the B-2's planform with its characteristic 'saw tooth' extensions that differ from previous flying wing designs and provides low-altitude penetration performance. Apparently, the B-21 design does not have this feature. US Air Force/Senior Airman Keith James

A considerable achievement compared too sub-50% for many years, and only 54% by 2017. At the time, a B-2 required 27 maintenance hours per flight hour, compared to 17 for a B-52H. However, when all required aircraft support activities (including those related to the B-2's low-observable coatings) are added in, the total is several times the benchmark figure.

However, in maintenance indicators the B-2 performed better than the B-52H. It achieved a lower break rate (the percentage of flights that landed with major Code 3 discrepancies) than the B-52H, 22% vs 43%, and a better 12-hour fix rate for such discrepancies, 55% vs 37%.

B-2 sustainment has also improved. Previously the aircraft had to be returned to Northrop Grumman's facility at Air Force Plant 42 at Palmdale, California for major overhauls on a seven-year cycle, this has now been extended to nine years.

Of the 20 B-2s in existence, 19 are operational with just 15 as combat coded. The New START nuclear arms control treaty counts a dozen B-2s, a reflection of the aircraft available for the nuclear deterrent mission. In June 2020, B-2 93-1087 *'Spirit of Pennsylvania'* became the B-2 test aircraft assigned to the 419th Flight Test Squadron, based at Edwards Air Force Base, California. This was no ordinary re-assignment. *Spirit of Pennsylvania* is the first B-2 to cycle through three programmed depot maintenance overhauls, which included restoration of its airframe, electrical and mechanical systems inspections, and restoration of the aircraft's low observable system, including removal and reapplication of the radar absorbing materials.

The Air Force is well aware of the threat posed by evolving technologies to the B-2's second-generation stealth capability, reducing its ability to penetrate anti-access/area denial (A2/AD) environments. Such realisation led to the 2019 decision to replace the B-2 with the B-21 Raider in the 2030s, even though the Spirit will be capable of operating into the late 2050s. Originally designed for a 20,000 flight-hour service life, each B-2 has been extended to some 40,000 hours.

Above: **This photograph shows the B-2's air intake, which from a design perspective had to reconcile stealth with the need to provide sufficient air for four engines. Similar compromises had to be made with the aircraft's exhaust, which is why images of them are not published.** US Air Force/Senior Airman Joel Pfiester

Below: **A B-2 lands at Whiteman Air Force Base following a round trip to Libya during Operation Odyssey Dawn.** US Air Force/Senior Airman Joel Pfiester

Upgrades

To ensure the fleet can accomplish its nuclear and conventional mission in highly defended and anti-access environments, periodic modernisation efforts must be undertaken to upgrade combat capability as well as improve the viability, supportability, and survivability of the weapon system.

In June 2020, the Air Force appointed Brigadier General John Newberry to head the Bomber Program Executive Office, a new position created to provide management of all three current bombers: B-1B Lancer, B-2 Spirit and B-52H Stratofortress.

Director Operational Test and Evaluation approved the B-2 Defensive Management System-Modernisation Milestone B Test and Evaluation Master Plan in October 2015, followed by approval from the Under Secretary of Defense for Acquisition, Technology, and Logistics for the engineering, manufacturing, and development phase on March 24, 2016.

DMS-M upgrades were to include a digital electronic support measures (ESM) subsystem, new ESM antennas, and modern display processing units

B-2 SPIRIT UNITS

Air Force Global Strike Command
509th Bomb Wing, Whiteman AFB, Missouri
13th Bomb Squadron
393rd Bomb Squadron

Air National Guard
131st Bomb Wing, Whiteman AFB, Missouri
110th Bomb Squadron, both associate units

Air Combat Command
53rd Wing, Eglin AFB, Florida
72nd Test and Evaluation Squadron, based at Whiteman

57th Wing, Nellis AFB, Nevada
325th Weapons Squadron, based at Whiteman

Air Force Materiel Command
412th Test Wing, Edwards AFB, California
419th Flight Test Squadron

to improve threat radar detection, identification, and avoidance capabilities. Associated software components were designed to integrate the upgraded systems with existing B-2 avionics systems to improve overall pilot threat awareness, threat reaction, and survivability. Northrop Grumman was the prime contractor and integrator, but the programme was cancelled in 2019 because it was over budget and behind schedule.

Faced with cost and schedule overruns and a reduced return on investment, the Air Force realigned funding to address reliability and sustainment of the B-2 cockpit display system until end-of-life. Only *Spirit of Pennsylvania* received a prototype DMS-M upgrade.

Cancellation of the DMS-M brought controversy because the B-2 force must continue to rely upon existing defensive systems in the knowledge that threat air defence systems are expected to have longer range and more lethal capabilities.

On February 13, 2020, Admiral Charles Richard, Commander, US Strategic Command told the Senate Armed Services Committee the increased risk [faced by B-2s] was one he could manage.

Before DMS-M got chopped, the Air Force had cancelled another major upgrade for the B-2 dubbed the 'advanced extremely high-frequency satellite communications programme'. This one designed to provide two-way high-speed connectivity until 2026-2028, when the B-21 was expected to enter service.

Current upgrades to the aircraft's communication and connectivity are focussed on adding new antennas.

This is an expensive process. Extensive testing is required to determine whether degradation of the aircraft's stealth capability exists and whether the aircraft was vulnerable to electronic or cyber-attacks. The new antennas also enable new cockpit displays to be installed.

Above: **B-2 Spirit 82-1070/WM *'Spirit of Ohio'* takes off from RAF Fairford, England, on March 13, 2020 during a Bomber Task Force Europe deployment.** US Air National Guard/TSgt Colton Elliott

Airmen from the active-duty 509th and Air National Guard 131st Bomb Wings operate a jet fuel pump on the flight line at RAF Fairford, England during a Bomber Task Force Europe deployment in March 2020. US Air Force/SSgt Kayla White

Lockheed Martin is supplying advanced graphics processors and modernised displays to provide adequate computer power to give the crew a much greater level of situational awareness and reduced vulnerability in dense threat environments. Information displayed is fed from the aircraft's mission transfer and beyond line-of-sight mission planning systems. Parts obsolescence and maintenance issues are other reasons for upgrading the displays.

Due to be completed by 2026, this programme builds on the aircraft's enhanced connectivity enabled by the Adaptable Communications Suite upgrade which included Link 16 connectivity. The Adaptable Communication Suite also comprises components that address new capabilities, parts and component obsolescence, and unforeseen maintenance issues. Components include electromagnetic interference certified keyboards, displays, computers, power supplies, keyboard/video/mouse switch box, and a system control panel.

The common very-low-frequency/low frequency (VLF/LF) receiver used for nuclear command and control is also currently being retrofitted to B-2 aircraft.

Another modification programme is underway to replace the current IFF transponder with an identification friend or foe Mode 5/S.

One offensive system upgrade scheduled to begin fielding in 2020 is known as Flexible Strike Phase 6.2, which includes hardware and software to enable integration of additional weapons plus the secure military GPS (GPS-M) capability.

Together with the radar-aided targeting system (RATS) software upgrade, which started in FY2019, it provides precision targeting in GPS-denied environments.

Above: **B-2 Spirit 82-1070/WM *'Spirit of Ohio'* at RAF Fairford, England, on March 13, 2020 during a Bomber Task Force Europe deployment.** US Air National Guard/TSgt Colton Elliott

Another programme, dubbed the Low Observable Signature and Supportability Modifications (LOSSM) is intended to reduce sustainment costs and improve stealth performance. On the ground, maintainers can use hand-held Next Generation Zonal Radar devices to check the B-2's low-observability coatings, which helps to increase the intervals between depot maintenance and overhauls.

Operations

Northrop Grumman's B-2 first entered combat during Operation Allied Force – the Kosovo conflict – on March 24, 1999 and demonstrated its capability for accurately delivering bombs on high-value targets. That said, during a mission flown on May 7-8, 1999, five JDAMs struck the Chinese embassy in Belgrade in error.

After flying combat operations against targets in Afghanistan, Iraq, and Libya, B-2s flew no combat missions between April 2011 and early 2017.

This changed on January 17–18, 2017 when two B-2s launched from Whiteman Air Force Base on a round-robin mission to strike a terrorist camp in Libya, under Operation Odyssey Dawn.

A third B-2 also launched from Whiteman as an air spare, before turning for home. Two ground spare aircraft were held on readiness as back-ups.

The two strikers, radio call signs Clip 11, and Clip 12 flew through international airspace until turning to hit their target near Sirte on Libya's central coast. The two B-2s hit their allocated target through a light cloud cover at midnight local time. A total of 85 GBU-38 500lb JDAMs were released and impacted the target in under a minute. No other aircraft could have delivered so many guided munitions simultaneously on a single pass over a target while retaining the element of surprise.

Given the conflict in Libya involves outside powers with access to early warning sensors and secure communications, even a little warning could have undercut the effectiveness of the strike.

As the B-2s pulled off the target, they were followed by several General Atomics MQ-9 Reaper unmanned combat air vehicles (UCAVs) used to destroy any vehicles escaping the bomb attack, and to provide battle damage assessment using their on-board sensors. The B-2s returned

Below: **Airmen operate a fuel pump while refuelling B-2 Spirit 88-0332/WM *'Spirit of Washington'* at RAF Fairford, England during a Bomber Task Force Europe deployment in March 2020.** US Air Force/SSgt Kayla White

to Whiteman at the end of a 33-hour round-trip during which each B-2 refuelled five times.

According to General Tod Wolters, currently the Supreme Allied Commander in Europe, this precision strike demonstrated that the US Air Force can put any target at risk, plus or minus a second, plus or minus a millimetre. Unstated, the mission also showed potential threats worldwide what global delivery of precision firepower really means.

Until the April 2020 announcement that the United States was scaling back its continuous bomber presence in the western Pacific, B-2s had been deploying to Guam – where typhoon-proof hangars were built for them in 2005. Deployments will continue but will be made with the objective of being operationally unpredictable, demonstrated by two B-2s deploying to Europe on May 7. Other B-2 deployments in 2020 included one to Diego Garcia, an island in the British Indian Ocean Territory, which had been used for previous missions in the US Central Command area of responsibility.

While the Air Force has said nothing about changing B-2 tactics to accompany its change in deployment schedule, it is possible that the last decade of its service may see a greater emphasis on its low-level penetration capabilities. An aspect of the stealth bomber built into the design back in the 1980s, when it was envisioned a force of 192 B-2s could hold at risk any number of Soviet relocatable intercontinental ballistic missile launchers.

Above & Below: **Crew chiefs assigned to the 509th and 131st Aircraft Maintenance Squadrons recover a B-2 at RAF Fairford, England.** US Air National Guard/ TSgt Colton Elliott

Weapons

The B-2 is the only long-range strike aircraft capable of penetrating and surviving today's advanced integrated air defence systems to deliver weapons against heavily defended targets. Many of these are hardened or deeply buried. And furthermore, the B-2 is the only bomber able to carry two 30,000lb Boeing GBU-57A/B Massive Ordnance Penetrator (MOP) weapons, the largest conventional bomb.

As part of the Flexible Strike upgrade, B-2s are being modified to carry up to 192 Small Diameter Bombs, either Boeing GBU-39s or Raytheon GBU-53s, and up to 16 Lockheed Martin AGM-158 (JASSM-ER) missiles. Eventually, the Spirit will be able to carry GBU-56 Laser JDAMs, and JDAM-5000s fitted with Hard Target Void Sensing Fuses.

Currently, the B-2 is the only bomber capable of delivering nuclear gravity bombs, the megaton-class B83-1 and up to eight B-61-7s or earth-penetrating B61-11s. The Flexible Strike upgrade will enable the aircraft to carry the improved B61-12, designed to defeat multiple target types, including those buried deep underground. Flight testing of the B61-12 has already been conducted on B-2s. Production of the B61-12 is planned to start in FY2022.

FORTY-EIGHT AND COUNTING

Mark Ayton describes the US Air Force's latest fighter jet, the F-15EX Eagle

IF YOUR IMPRESSION of the F-15 Eagle is one of a modern fighter aircraft, you might be surprised to know it's over 48 years old.

It was July 27, 1972 when McDonnell Douglas test pilot Irv Burrows flew F-15 71-0280 on the type's maiden flight from Edwards Air Force Base, California.

Built at the McDonnell Douglas facility adjacent St Louis-Lambert Field, the aircraft was unveiled there on June 26 and airlifted to Edwards in July. The aircraft was used for flight envelope, handling qualities and stores carriage testing by a combined McDonnell Douglas-US Air Force F-15 Joint Test Force until November 1975. Following an illustrious flight-test career, the aircraft was assigned to the Air Force Orientation Group based at Gentile Air Force Station, Ohio. Between 1979 and 1991, the aircraft was exhibited to the American public at shows and displays around the nation. Today, the aircraft is on display at the US Air Force History and Traditions Museum at Lackland Air Force Base, Texas.

Fast forward to the first quarter of 2021, St Louis-Lambert Field and the roll-out of the Boeing F-15EX; the latest variant of the two-seat F-15 Strike Eagle family, but single pilot operable.

Externally similar to the F-15E with the same outer mould line, internally the F-15EX is a transformation in terms of how its OFP software works, in terms of its sensor suite and its future upgradability. But the transformation also includes structural changes. Both the wing and the fuselage have been strengthened to improve fatigue-life, based on discoveries found during phase maintenance inspections.

An Advanced Eagle: F-15EX

According to Boeing's F-15 Program Manager, Prat Kumar: "The analysis undertaken on individual pieces of the structure that we've strengthened to enable the customer to get a longer useful life is very detailed and allows us to build new aircraft more efficiently. There have been hundreds of small changes on the inside of the airframe that make today's Eagle better.

One new enabling aspect of the Advanced Eagle is an open mission system architecture and processor. These allow rapid insertion of app-based software, which in turn enables insertion of, for example, new antennas, or the ability to conduct a new role like manned-unmanned teaming or functioning as a data node in the nascent Air Force Advanced Battle Management System dubbed ABMS. These examples are only made possible because of the aircraft's digital backbone and a fibre-optic data bus installed throughout the aircraft."

Weapon payload is another primary capability. The F-15EX will become the first aircraft in the US Air Force inventory capable of carrying very large hypersonic stores measuring 20ft in length and weighing more than 7,000lb.

Boeing opted to not incorporate low observable

design features on the Advanced Eagle, primarily because it was not of interest to the Air Force. Commenting, Prat Kumar said: "What we offer with the F-15EX and its advance jamming capability is survivability against a broad range of frequencies. The aircraft is affordable because it doesn't require low-observable coating maintenance and offers a rapid means to adapt software. An advantage for adjusting its electronic warfare suite to counter new and emerging threats."

Both the front and the aft cockpit have undergone redesign as Prat explained: "As we learned about mission management, especially from the F-22 Raptor and F-35 Lightning II, we realised the amount of sensor and data fusion provided to the pilot was increasingly important. Our approach was to equip each cockpit with a large 19 x 11-inch high-definition display, rapidly adaptable, easily customised and synchronised to the head-up display.

"We also realised the importance of rapid weapon targeting and do so with a helmet-mounted sight. F-15EX has a digital helmet-mounted sight and a large area display in both the forward and the aft cockpits. A digital helmet-mounted sight attached to the tops of the pilot and the weapons system officer's helmets interconnects with the aircraft and depending on which mode is selected, displays different information. It provides them with advanced targeting information and greater situational awareness."

Digital capability of the F-15EX comprises a variety of systems. Upfront is the APG-82 radar's active electronically scanned array (antenna) with the largest array face currently available on a fighter in the world. The larger the antenna, the smaller the detectable target at a greater range.

Located just aft of the radar is the mission computer known as the Advanced Display Core Processor II (ADCP II), which runs all of the avionics systems on the aircraft and manages all the data migrating around the aircraft. The processor has oodles of memory, gargantuan processing power enabling it to operate at 87 billion instructions per second, and bags of input-output bandwidth to meet the F-15EX's future and projected sub-system demands. ADCP II also enables full exploitation of the APG-82 radar's capabilities such as tracking a large number of targets, operating mode simultaneity, and providing increased track data.

Right next to the mission computer is the Multifunctional Information Distribution System-Joint Tactical Radio System. Abbreviated to MIDS JTRS, it's a four-channel radio designed to run the complex Link 16 data link waveform, and up to three additional communication protocols, including the airborne networking waveform. The MIDS JTRS will connect the F-15EX with all of the other aircraft types in the Air Force inventory equipped with the Link 16 system.

Located close by to the MIDS-JTRS is the electronic warfare system produced by BAE Systems, designated the ALQ-250 and called the Eagle Passive/Active Warning and Survivability System (EPAWSS).

APG-82 Radar

Raytheon's APG-82(V)1 active electronically-scanned array radar can simultaneously detect, identify, and track multiple air and surface targets at longer ranges than previous Eagle radars. Longer stand-off range facilitates persistent target observation and information sharing. Compared to its predecessor APG-63(V)3, the APG-81(V)1 provides

- Near-simultaneous interleaving of selected air-to-air and air-to-ground functions.
- Enhanced air-to-air and air-to-ground classified combat identification capabilities.
- Longer range synthetic aperture radar (SAR) air-to-air target detection and enhanced track capabilities. Longer range and higher resolution air-to-ground radar mapping.
- Improved ground moving target track capability.

The APG 82(V)1 antenna and power supply are from the APG-63(V)3 radar model, and the radar receiver/exciter and CISP (common integrated sensor processor) are based on the APG-79 AESA system.

ALQ-250 EPAWSS

According to BAE Systems, the ALQ-250 all-digital system collects and processes electromagnetic energy to instantaneously capture a 360° aerial field of view to provide a comprehensive picture of the battlespace around the aircraft. This gives the pilot maximum situational awareness, helping to identify, monitor, analyse, and rapidly respond to potential threats. EPAWSS has a broad instantaneous bandwidth and high speed scanning capability to detect all radio frequency (RF) threat classes including low probability of intercept and modern agile threats. To counter threats, the ALQ-250 electronic countermeasure technique toolbox can be programmed to defeat legacy and modern threats.

BAE Systems lists the following features and benefits

- Offensive and defensive digital electronic warfare capabilities
- Modular, scalable, open-system architecture
- All-aspect, broadband radar warning and geolocation
- Multi-spectral, radio frequency (RF) and infrared (IR) countermeasures
- Simultaneous jamming without interfering with radar and radar warning receiver
- Interoperable with active electronically scanned array radar
- Integrates radar warning and countermeasures into one system
- Increased situational awareness
- Reduces F-15 electronic warfare footprint
- 50% more chaff and flares than aircraft today

EPAWSS is designed to provide indication, type, and position of ground-based RF threats as well as bearing of airborne threats with the situational awareness needed by the pilot to avoid, engage or shoot down the threat. It also defends against RF and infrared threat systems detecting or acquiring accurate targeting information prior to engagement thus complicating and/or negating an enemy threat targeting solution. The system counters threats through its suite of components using electro-optical and RF techniques.

Prat said the ALQ-250 detects signals throughout the 360° sphere around the aircraft, across a very large frequency band, and determines the best technique to send a jamming signal back against the threat.

Chamber Testing

In April 2020, F-15E Strike Eagle 90-0252/ET was drawn from the 40th Flight Test Squadron based at Eglin Air Force Base and outfitted with the ALQ-250. It was deployed to Edwards Air Force Base, California and underwent critical electronic warfare testing in the Benefield Anechoic Facility, using its RF anechoic chamber. The facility is the largest in the United States and the

first of multiple test phases at the BAF was completed in April 2019. Ongoing tests are required to collect the data to establish the integration of the ALQ-250 radar and missile warning capabilities and its electronic counter measures onto the F-15E Strike Eagle. The current electronic warfare self-protection suite fitted on the Strike Eagle uses 1970s-era analogue technology and was designed for 1980s-era radar-based ground and air threats.

The testing is a collaborative effort among the F-15 System Program Office at Wright-Patterson Air Force Base, Ohio, the 96th Test Wing at Eglin, the 412th Test Wing at Edwards, Boeing, and BAE Systems.

Further tests are planned until the ALQ-250 is certified for service and released to the F-15E and F-15EX fleets.

Note the EPAWSS sensor adjacent the aft cockpit. All images Boeing Defense unless noted.

Legion Pod

One of the F-15EX's primary sensors is an infrared search and track (IRST) system housed in a pod carried on the under fuselage centreline station. An IRST provides a passive means to detect and track objects from infrared radiation by scanning a large volume of airspace ahead of the aircraft. This capability complements the radar to enhance the aircraft's survivability and lethality against air-to-air threats and provides the aircraft mission computer track file data on infrared targets.

Infrared energy can be generated by aircraft systems or by the friction produced by the aircraft's skin as it flies through the air. Any such detection enables the pilot to slave the radar onto the emissions for lock-on, or by geolocation calculated by the high-speed processor using interferometry.

A centreline pod carried on the under fuselage centreline station is depicted in Boeing's F-15EX artist renderings. That pod looks like Lockheed Martin's modular sensor system dubbed the Legion Pod.

According to Lockheed Martin, the Legion Pod is a multi-function sensor system that supports collaborative targeting operations in radar-denied environments. Housed in a 16-inch diameter fuselage, Legion Pod's baseline configuration includes an IRST21 sensor and advanced processor for high-fidelity detection and tracking of air-to-air targets.

Legion Pod has completed flight tests and integration on F-16, F-15C and F-15E aircraft, successfully demonstrating its detection and tracking capabilities in representative threat environments. Equipped with a common interface, it's easily integrated onto any aircraft without affecting that aircraft's operational flight programme software. And, due to its open architecture, the system can accommodate and operate multiple sensors simultaneously, depending on the operator's requirements.

Packing two AIM-9X Sidewinders, ten AIM-120 AMRAAMs and a Legion Pod, these F-15EXs are loaded for a fight.

Sales Pitch Justification

Boeing makes a series of assertions about the F-15EX on its on line web pages, which the author discussed with Boeing F-15 Program officials.

Will the F-15EX be able to conduct other missions other than preserving air superiority and homeland defence missions?

Responding, Prat Kumar said: "Certainly, and what the customer asked us for, was a way to rapidly replace F-15Cs. That was their focus. What we offered was something that would allow them to do that very quickly from the standpoint of training pilots and maintainers. Conversion of F-15C units to the F-15EX will involve very rapid transitions. That's the Air Force's first goal.

"It will be able to conduct the homeland defence role even better than the F-15C because it carries additional fuel in conformal fuel tanks and additional air-to-air missiles on previously unpopulated stations one and nine. It also brings a full air-to-ground capability, should the Air Force want to use the F-15EX for that mission set. Lastly, and very importantly, it has enormous growth potential for integrating future roles, specifically manned-unmanned teaming, and rapid insertion of emerging technologies like artificial intelligence and hypersonic weapons, they will be prominent weapons on the F-15EX."

How has the team designed for and expects to achieve a 20,000-hour airframe life?

According to Prat Kumar, F-15EX airframe life was defined by the Air Force based on its usage, maintenance, and inspection schedules for the F-15C Eagle. Prat highlighted Boeing's deep understanding of the F-15 weapon system, how the Air Force uses the jet, what its maintenance practices are, and what programmed depot maintenance involves. He said: "It's not like starting with a new aircraft that you have to learn from the beginning. We conduct full scale fatigue testing at the St Louis plant. This involves subjecting real F-15 aircraft to constant stress testing using numerous hydraulic rams and recording data about the entire structure of the aircraft, which is used to strengthen the airframe of each new model. The EX design benefits from all those years of accumulated data, F-15 production and maintenance experience."

How does the Advanced Eagle achieve more speed, range, and payload and what are those criteria set against?

Answering, Prat Kumar said: "We try really hard to not compare our platform with others, because we feel that an Air Force needs different options for different mission sets from its inventory. Speed, range, and weapons payload are facts based on platform capabilities. They are reality, not Boeing assertions. For example, you can look up what the range of an F-35 is, and you can look up the range of an F-15EX, and its many miles further on an EX."

How does the Advance Eagle provide the lowest operating costs, and what other fighter aircraft is that compared to?

Prat acknowledged that it was a good question, and one that Boeing tries its very best to defer to those who can compare apples with apples, i.e. the Air Force because it has the data, operates both aircraft and knows the exact costs.

He said: "Because the Air Force has operated the F-15 for a very long time, data about operating costs are already held in its system. So, the Air Force has a lot of confidence when Boeing states an F-15C costs between $27,000 and $29,000 per hour to operate. That's fact, it's just reality, as published by the Cost Assessment and Program Evaluation office."

How is unmatched survivability achieved?

Prat started his answer by using an analogy to an NFL team, which needs both a good offence and a good defence. He said: "We think the F-15 brings both in a very balanced way. There are platforms that rely entirely upon hiding for their survivability. The F-15 relies on jamming and killing in equal measure, and it's good at both. That's why we make that assertion. That said, the F-15 is designed for a different threat environment to other platforms.

"That's the great thing about the Air Force model. It can use the right asset for the situation. On night one of the air campaign you need the high-end stealth platforms. Two or three days in when a lot of the high-end threats have been struck, then it doesn't make sense to continue to provide weapons for the Force Commander with aircraft that are both expensive and carry so few weapons, when an F-15EX can show up with 28 small diameter bombs and stay on station for much longer. It just makes sense from a cost standpoint."

How is unmatched manoeuvrability possible?

As an experienced pilot who has flown a lot of different aircraft, Prat said there is nothing that compares from the performance of a new Advanced Eagle: "It offers 9Gs of acceleration, Mach 2.5, unbridled handling characteristics with fly-by-wire, enormous power out of the big motors. It is spectacular. The F-22 is in its own space, but of any of the fighter aircraft in production right now, from a manoeuvrability standpoint, I'd take an F-15EX any day of the week. Its performance is eye-watering."

How does Boeing justify describing the APG-82 radar as the most powerful such system in operational use today?

In response, Prat said: "When we think about a radar, it's less about the system as an entity, but how the radar system is being employed. The radars that you mentioned [APG-77/F-22, APG-81/F-35, Irbis-E/Su-35, Byelka/Su57] are fundamentally different because they are designed to incorporate sensors that passively acquire targets and then use the radar for searching the space to confirm the target. Also, the antenna has to sit behind a radome to minimise the aircraft's radar cross section. None of that is true for the APG-82, which is an enormously powerful radar fitted with a big radar dish, that functions with an enormous amount of power. When you're trying to detect small targets, especially ones that are not emitting, there's nothing better. Should the Air Force need to defend the homeland from a cruise missile attack, there is no better choice of radar than the APG-82."

How do fly-by-wire controls improve reliability and maintainability by a factor of five?

Responding, Prat explained how a fly-by-wire system simply controls hydraulic actuators via the flight control computer and wiring and stated that Boeing has demonstrated fly-by-wire to be very reliable with the Saudi F-15SA fleet, but he had to concede he did not know how the factor of five times was calculated.

A Pilot's Perspective

Matt Giese is Boeing's F-15 chief test pilot. He works for a department called Boeing Test and Evaluation, which has end-to-end involvement from the beginning of system design until the final flight test and delivery of the aircraft to the government customer.

Matt served in the active-duty Air Force and flew F-16, F-15, and F-22, and continues to serve as a reservist in a non-flying role. He has much experience flying Advanced Eagles such as the Saudi F-15SA and the Qatari F-15QA. Discussing the nascent F-15EX, Matt said it has three major pillars; digital fly-by-wire flight control systems; GE Aviation F110-GE-129 engines; and its mission systems, including sensors and an electronic warfare system.

This shot depicts a hypersonic missile ascending to its cruise altitude after launch from the under fuselage centreline station of an F-15EX.

Digital Fly-by-Wire

Matt explained the benefits that F-15EX pilots will gain from the aircraft's four-channel, quad-redundant, digital fly-by-wire flight control system. He said: "It allows the pilot to focus more on the mission event because the digital fly-by-wire system design provides stability, efficiency, predictability, reliability and a very high level of performance. Not just at Mach 2.5 and high altitude but more importantly at slow speeds and a high angle-of-attack.

"The Advanced Eagle has been tested and vetted throughout the entire flight envelope - low and slow, high and fast, out to Mach 2.5, high angles-of-attack - such that the aircrew can fly the aircraft with ease, in the knowledge that its flight control system will protect them and the aircraft alike, allowing them to focus on the mission tasks. Around 15,000 test points were performed.

"Advanced Eagle has two flight control computers with two branches, each branch controls the fly-by-wire system. To aid the pilot, a help page is always displayed in the cockpit showing inputs to the flight control system and the outputs to each individual control surface. Even at a glance, the pilot can determine the health of the system; green is good, yellow indicates redundancy is being lost, and red shows it's starting to fail."

Big Ole Motors

Given the F-15EX will have plenty of power to operate, generated by two GE Aviation F110-GE-129 turbofan engines each rated at 29,000lb, it should have no problem conducting the roles currently performed by the F-15C. Neither should it struggle to fly high and fast and give energy and kinematics to its air-to-air missiles. Matt said the F-15EX is on par with the F-22 in many aspects of manoeuvrability thanks to the GE engines and its digital fly-by-wire controls.

The F110-GE-129 EFE is a two-spool, low-bypass, axial-flow turbofan engine with afterburner. Its main components forward to aft are; a front frame, a three-stage long chord blisk fan (driven by the two-stage low-pressure turbine), a fan frame, a nine-stage high-pressure compressor (driven by the single stage high-pressure turbine), a combustion diffuser nozzle, a turbine section (high-pressure turbine, low-pressure turbine), a turbine frame, an augmentor mixer, an advanced close-coupled radial augmentor, an exhaust, and a convergent-divergent type nozzle.

The engine is equipped with a digital engine control unit which controls fuel flows, rotor speeds, variable geometry, pressures, and temperatures in the engine.

An F110-GE-129 engine measures 182 inches in length, has a 46.5-inch max diameter, and weighs 4,010lb.

GE Aviation developed the F110-GE-129 EFE (Enhanced Fighter Engine) using the following low risk technologies

- a three-stage long chord blisk fan for greater efficiency, an increased inlet airflow rated at 275lb/sec, and a reduced parts count. This feature was adapted from the B-2 Spirit's F118-GE-100 engine
- an advanced radial augmentor derived from concepts used in the F120 (Lockheed YF-22 and Northrop YF-23) and F414 (Boeing F/A-18 Super Hornet) engines that reduces complexity, improves maintainability and reliability, and improves parts life by over 50% due to advanced cooling of the augmentor parts
- a lightweight filament-wound composite fan duct
- control system enhancements that manage the engine's power up to 34,000lb of thrust

GE Aviation delivered two F110-GE-129 engines to Boeing for installation in the first F-15EX in September 2020. It remains the only type of engine certified for the fly-by-wire F-15EX. GE Aviation made a long-term commitment with the investment required to qualify the F110-GE-129 engine on variants of the Advanced Eagle including the F-15EX.

Mission Systems

According to Matt, the F-15EX's two primary mission systems are the APG-82(V)1 radar and the ALQ-250 EPAWSS electronic warfare suite. "Their combined capability make the F-15EX extremely survivable in today's battlespace."

Having flown the F-22 for 12-years, Matt believes there are multiple ways to achieve the same or similar battlespace affects with the F-15EX.

First F-15EX, serial number 20-2001, in final assembly at Boeing's St Louis production facility.

An F110-GE-129 turbofan engine on a test rig. GE Aviation

Discussing this aspect, he said: "Being equipped with the most powerful large array radar antenna in the world gives the F-15 far superior performance in some mission elements. Add in the effect of EPAWSS with its offensive and defensive capabilities, and manage the two systems together, and in many cases, it results in a greater, more supportive and complimentary battle space effect than you would get with a stealth fighter."

Matt was asked if the battlespace picture presented on the large area display is fused together from data fed from the sensors, and whether that picture gives the pilot surety that if going into harm's way, he or she would know where all the threats are located?

Unsurprisingly, he would not discuss details of sensor fusion on the F-15EX. However, he said the large area high-resolution display provides a very large battlespace picture, one that shows inputs from all of the aircraft's sensors. Matt said: "The situational awareness afforded to an F-15EX aircrew will be far beyond that presented in cockpit of an F-15C or an F-15E, and on par or exceed the fidelity of F-22 and F-35 displays. Threats are identified clearly and quickly, which certainly increases the pilot's situational awareness. That's all possible because of the ADCP II mission computer which filters out the most important information to avoid overloading the pilot with cues and targets around the battlespace."

Measuring 19 x 11 inches, the F-15EX cockpit large area display is designed and produced by Israeli company Elbit Systems and provides the basis of Boeing's Advanced Crew Station (ACS). "The display integrates tactical data, mission planning and flight information into a complete situational picture," continued Matt. "It responds to specific mission phases and pilot controls. Boeing's primary objectives for designing the ACS were to improve the pilot's interaction with the aircraft and operate in synch with the digital helmet-mounted cueing system. These aspects improve the pilot's situational awareness and increase mission effectiveness."

For an aircraft of its size, the F-15EX will be able to carry an unprecedented weapon payload thanks in part to the fly-by-wire design and if the Air Force chooses to integrate the new Advanced Missile Bomb Ejector Rack dubbed AMBER. Previously unpopulated stations one and nine can now carry air-to-air missiles, increasing the F-15's missile loadout to 12, which increases to 22 when the AMBER rack is used. Boeing developed the AMBER rack as part of a research and development programme as a means to carry additional air-to-air missiles or other munitions.

Commenting on that possibility from a mission systems standpoint, Matt said the combination of digital design, integrated mission systems, and a potential missile loadout of 22, makes the F-15EX a highly lethal platform.

Lot 1 Contract

In mid-July, the Air Force awarded Boeing a contract valued at nearly $1.2 billion for the first Lot of eight F-15EX aircraft.

Under the terms of the contract, Boeing will provide for the design, development, integration, manufacturing, test, verification, certification, delivery, sustainment, and modification of the F-15EX aircraft, including spares, support equipment, training materials, technical data, and technical support.

Under current plans, the Air Force plans to procure 76 F-15EX aircraft over the five-year Future Years Defense Program; the eight in Lot 1 were approved in the FY2020 budget and 12 were requested in FY2021.

Commenting on the contract award, General Mike Holmes, the then commander of Air Combat Command said: "The F-15EX is the most affordable and immediate way to refresh the capacity and update the capabilities provided by our aging F-15C and F-15D Eagle fleets."

For the Air Force, the F-15EX represents more than new iron on the ramp. As a major design series type, it will require minimal transitional training or additional manpower and little to no infrastructure changes at the bases selected to host the type.

According to Gen Holmes: "The F-15EX will be ready to fight as soon as it comes off the line. When delivered, we expect bases currently operating the F-15 to transition to the new EX platform in a matter of months versus years."

According to the Air Force, the first eight F-15EX aircraft will be assigned to Eglin Air Force Base, Florida to support developmental and operational testing. Eglin is home to Air Force Materiel Command's 40th Flight Test Squadron (developmental test) and Air Combat Command's 85th Test and Evaluation Squadron (operational test). Assigning the jets at Eglin will allow the co-located test squadrons to share the aircraft and work in parallel, but independently of each other, to accomplish both test efforts in the least amount of time and cost. Eglin will receive the first two aircraft (serial numbers 20-2001 and 20-2002) in the second quarter of FY2021, followed by the other six in FY2023.

A Lockheed Martin Legion Pod on an F-15E Strike Eagle's under fuselage centreline station.
Lockheed Martin

Only GE's advanced F110 engine is fully integrated into the F-15EX fly-by-wire system and has been delivered to the US Air Force, eliminating the risk of development time and cost. The F110-129 is built with capability in reserve to adapt to changing global threats and mission needs for decades to come. GE's F110—fully committed to F-15EX since day one.

Integrated. Certified. Delivered.

geaviation.com/F110

THE BUSY HUNDREDTH

Flying elderly KC-135 aircraft, which are seemingly irreplaceable, Bob Archer explores the modern day Bloody Hundredth based at RAF Mildenhall, England.

KC-135R Stratotanker 57-2605 takes off at RAF Mildenhall, England, on April 24, 2019 as part of a mission assurance exercise. During the event, the 100th Air Refueling Wing successfully generated all 32 scheduled Stratotanker missions, and off loaded 762,000lb of fuel to 90 receivers. US Air Force/Senior Airman Benjamin Cooper

DURING AUGUST 2020, the then United States Defense Secretary, Mark Esper announced that the closure of RAF Mildenhall, England was not going to happen, and instead, the base would remain open 'as a commitment to NATO'. Esper merely stated what everyone in the area had surmised for a long time - that Mildenhall was far too important, both strategically, and physically to be closed simply as a budgetary measure. The resident units would not be moving, negating plans to relocate the 15 KC-135s of the 100th Air Refueling Wing to Ramstein Air Base, Germany. Apart from there being no ramp space at Ramstein, there was also no infrastructure to accommodate the wing's personnel, numbering well in excess of 1,000. Mildenhall base personnel are believed to have lobbied hard for the facility to remain open.

The 100th Air Refueling Wing was formed in February 1992, although a unit dubbed the European Tanker Task Force had been in situ at Mildenhall since August 1970. Prior to the formation of the 100th Air Refueling Wing, KC-135s from all of Strategic Air Command's Bomb Wings held temporary duty at Mildenhall. From the early 1960s, a small number of KC-135s were maintained in Europe to support the strategic reconnaissance mission, conducted by RB-47s and later

RC-135s, deployed to the UK, with aerial refuelling. Initially the reconnaissance jets operated from RAF Brize Norton and from 1965 from RAF Upper Heyford. That mission continues today by supporting the resident RC-135-equipped 95th Reconnaissance Squadron based at Mildenhall.

Throughout the course of a single year, the 100th Air Refueling Wing's customers comprise a diverse selection of receivers, who require tanking at the most unsociable of hours. Shortly after the closure announcement was made, the first stages of the draw down process were implemented, including a reduction in the base's daily opening hours for normal flight operations. As soon as the closure notice was lifted, the base reverted to round-the-clock operations. A sure case of bad politics versus good politics.

While many of the 100th's sorties are flown to enable the six fighter squadrons assigned to US Air Forces in Europe to remain proficient in aerial refuelling, other receivers are drawn from the air arms of NATO nations in mainland Europe. Based on its current operational tempo, the 100th Air Refueling Wing flies some 1,200 sorties annually.

Air Bridge to US Central Command

The ongoing US military presence in the Middle East, largely at Al Udeid Air Base, Qatar, means perpetual deployment of KC-135s assigned to active-duty and reserve components wings. Many of the transiting KC-135s stage through Mildenhall for refuelling, crew rest, minor maintenance, and a host of other support requirements all provided by personnel of the 100th Air Refueling Wing. This is an almost daily activity at the Suffolk base.

KC-135s holding temporary duty in the Middle East are organised under the control of US Central Command dubbed CENTCOM. Aircraft and personnel from all temporary duty units are assigned to a parent Air Expeditionary Wing, while the 22nd Expeditionary Air Refueling Squadron is based at Incirlik Air Base, Turkey with aircraft drawn wholly from the 92nd Air Refueling Wing based at Fairchild Air Force Base, Washington.

Consequently, the 100th Air Refueling Wing rarely has its aircraft operating in the Middle East, though its area of responsibility is substantial, largely as a consequence of its parent command's area of responsibility; United States Air Forces in Europe - Air Forces Africa.

Wing operations extend from the eastern sector of the Atlantic Ocean, across the whole of Europe, with the exception of Russia and Belarus, throughout the safer nations of north Africa, throughout the Mediterranean and much of the Black Sea region.

Understandably, the 100th Air Refueling Wing cannot conduct all of its tasked sorties from Mildenhall, and regularly deploys one or more aircraft to Moron Air Base and Naval Air Station Rota in Spain. These detachments are held to provide aerial refuelling to US aircraft in Africa. Additionally, 100th Air Refueling Wing tankers temporarily operate from other

Below: **Exercise Wolffpack, staged at the end of September 2020 was a three-day event which included 12 resident KC-135s performing a 'baby elephant walk' along the runway. Despite the decidedly unfriendly weather, the aircraft flew their allocated sorties without any problems.** 100th Air Refueling Wing via Bob Archer

American and NATO bases in Europe for exercises and to support American fighter aircraft deployed to Europe.

Supporting CENTCOM

It is not uncommon for US aircraft, especially strategic bombers, to deploy to the CENTCOM area of responsibility non-stop from their home bases. The 100th Air Refueling Wing normally launches an appropriate number of KC-135s to rendezvous and aerial refuel the bombers, usually over the eastern sector of the Atlantic Ocean, dragging the bombers on their eastbound journey with multiple hook-ups.

But work supporting CENTCOM-bound aircraft is not limited to America's strategic bomber types, C-5M Galaxy, C-17A Globemaster III strategic airlifters, E-3 Sentry radar control aircraft, and occasionally E-4B national command aircraft also call upon the services of the 100th. Most recently, Mildenhall's resident tankers air refuelled the E-4B carrying the then Defense Secretary, Mark Esper to Delhi, India for a four-day visit.

Two KC-135s are required to provide a gas-guzzling, 1970s vintage Boeing 747 with enough fuel for such a flight with a third aircraft also launched as an air spare. Such sorties are conducted at all hours of the day and night and involve the off load of many thousands of pounds of fuel during multiple hook-ups. This type of aerial refuelling mission enables the receiver aircraft to arrive at its destination much quicker than making an en-route stopover and provides training for all aircrews involved.

Left: **A 100th Air Refueling Wing KC-135 on the runway at Mildenhall during an evening departure in February 2020.** US Air Force via Bob Archer

Right top to bottom: **During June 2020, KC-135R 63-8878 appropriately named 'Boss Lady' flew with an all-woman crew for the first time. Technical support was also provided by an all-woman team.** 100th Air Refueling Wing via Bob Archer

The all-female sortie during June 2020 refuelled a B-2 Spirit bomber, which is seen connected to the boom of the KC-135. 100th Air Refueling Wing via Bob Archer

Left: **One mission tasked to the 100th Air Refueling Wing was to extend the range of the 48th Fighter Wing F-15E Strike Eagles when deployed to Poland to bolster NATO's eastern flank.** 100th Air Refueling Wing via Bob Archer

US-based fighter squadrons deploying to the EUCOM and CENTCOM areas of responsibility are usually dragged on their eastbound journeys by tankers launched from the United States, though some deployments are supported by the 100th Air Refueling Wing in the eastern sectors of the Atlantic Ocean.

Current Fleet, Future Fleet

Mildenhall-based 100th Air Refueling Wing currently operates with a primary aircraft authorisation of 15. This is the number of aircraft authorised to a unit for performance of its operational mission, and the basis for the allocation of operating resources, manpower, support equipment and flight hours funding.

Fifteen aircraft is currently considered as adequate for the number of commitments tasked to the 100th Air Refueling Wing. The wing's current flying component, the 351st Air Refueling Squadron, has 27 combat mission-ready KC-135 aircrews.

However, the word circulating in the KC-135 community suggests the number of tankers assigned to the 100th Air Refueling Wing may increase slightly during 2021, with a second squadron formed. Furthermore, the 349th Air Refueling Squadron has been identified as the unit. A spokesperson for the 100th Air Refueling Wing would not confirm or deny the possibility.

Currently stationed at McConnell Air Force Base, Kansas as a component squadron of the resident 22nd Air Refueling Wing, which is transitioning to the KC-46A Pegasus could enable the 349th Air Refueling Squadron to re-join the 100th. During World War Two, the 349th and 351st Bomb Squadrons were assigned to the 100th Bomb Group.

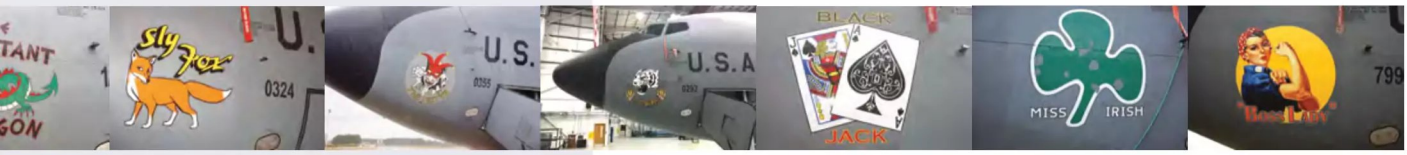
Any additional KC-135 aircraft stationed in Europe (at Mildenhall) would permit African operations to expand.

At present, there is no definitive plan to re-equip the 100th Air Refueling Wing with the KC-46A Pegasus since the Air Force still has to get the type past the operational certification finish line.

Pegasus is currently being introduced to service with the active-duty 22nd Air Refueling Wing and New Hampshire Air National Guard's 157th Air Refueling Wing based at Pease Air National Guard Base.

In the future however, the European and Pacific theatres will receive new tanker aircraft, though it is not known whether the KC-46 or the follow-on KC-Y will be the type involved.

Below: **As part of the 75th D-Day anniversary, 100th Air Refueling Wing KC-135R 62-3551 had extra commemorative markings applied, similar to those applied to B-17s of the 100th Bomb Group during World War Two. Originally intended for short-term retention, those on 62-3551 were still displayed 18 months later.** Bob Archer



However, during August 2020, a pair of KC-46s assigned to the 22nd Air Refueling Wing spent a few days at Mildenhall flying cargo to other destinations in Europe, evaluating loading methods, and conducting aerial refuelling with USAFE fighters.

Historic Link

Based at RAF Thorpe Abbotts near the market town of Diss on the Norfolk-Suffolk county line, and some 23 miles east of Mildenhall, the 100th Bombardment Group flew B-17 Flying Fortress bombers during 22 months of aerial combat between June 25, 1943 and April 20, 1945. According to official 8th Air Force records, the group flew 306 missions, 8,630 credited sorties, and dropped 19,257 tons of bombs.

Also, during May 1945, the 100th Bombardment Group flew six low-level missions to the Netherlands, dropping food to hungry Dutch citizens, dubbed 'Chowhound' Missions.

The 100th Bombardment Group's losses in that period placed it in the top three of losses suffered by the heavy bombardment groups assigned to the US Army Air Force's Eighth Air Force.

Above: **Examples of current nose art applied to 100th Air Refueling Wing KC-135s.** Bob Archer and US Air Force/Senior Airman Luke Milano

Right: **A 100th Air Refueling Wing KC-135 preparing to connect with a 352nd Special Operations Wing MC-130J Commando II during a low-level sortie over the North Sea.** 100th Air Refueling Wing via Bob Archer

In total, the Thorpe Abbotts-based group filed 184 missing air crew reports, lost 785 men killed outright or missing in action, 894 men taken as prisoners of war, and 229 aircraft destroyed or rendered unsuitable for flight. Terrible statistics of young airmen lost in war, and yet the group earned the nick name 'The Bloody Hundredth' based on its combat losses.

Personnel from the present day 100th assist the museum at Thorpe Abbotts with all kinds of help.

Furthermore, the 100th Bombardment Group's original black square and white D tail marking is worn by all KC-135s assigned to the 100th Air Refueling Wing; the only Air Force unit permitted to display World War Two style tail markings. In addition, all 15 Mildenhall-based KC-135s carry nose art and names similar to those applied to the B-17 Flying Fortress aircraft of the 100th Bombardment Group.

As each KC-135 is returned to Oklahoma Air Logistics Center at Tinker Air Force Base for programmed depot maintenance, and eventual reassignment, a new tanker is delivered to the 100th ensuring a full complement is maintained.

CURRENT 100TH AIR REFUELING WING NOSE ART

KC-135 serial no	Name	B-17 serial no	Fate
57-1440	High Life	B-17F 42-30080	Abandoned in Switzerland
57-1493	Wolf Pack	B-17F 42-30061	Scrapped in the United States
57-2605	NKAWTG Biggasbird	B-17F 42-30799	Crashed March 6, 1944
58-0036	Homesick Angel	Unknown	Unknown
58-0100	100 Proof	B-17G 42-98015	Scrapped in the United States
58-0113	All American Girl	B-17G 42-37936	Missing in action, Germany January 10, 1945
59-1513	The Reluctant Dragon	B-17G 43-38011	Damage beyond repair, salvaged December 1, 1944
60-0324	Sly Fox	B-17F 42-30278	Missing in action, Germany March 6, 1944
60-0355	The Jester	Unknown	Unknown
61-0292	The Savage	B-17G 42-31710	Missing in action, Germany May 8, 1944
61-0315	Our Gal Sal	B-17G 42-31767	Scrapped United States
62-3540	Holy Terror	B-17F 42-30723	Crashed October 10, 1944
62-3551	Black Jack	B-17F 42-30086	Damaged beyond repair, North Africa
63-8878	Boss Lady	B-17G 42-102611	Missing in action, June 17, 1944
63-8887	Miss Irish	B-17G 42-31968	Damaged beyond repair, Thorpe Abbotts

PANEL TITLE

100th Air Refueling Wing
The 100th Air Refueling Wing hosts many subordinate units to meet its responsibility for the day-to-day running and administration of RAF Mildenhall. Responsibility is held for US Air Forces in Europe-United Kingdom, the 352nd Special Operations Wing based at Mildenhall, the 501st Combat Support Wing at RAF Fairford, Gloucestershire, a small US Army element in the UK, and five other partner units.

100th Operations Group
Responsible for planning and execution of aerial refuelling operations across Europe and Africa, the 351st Air Refueling Squadron and the 100th Operational Support Squadron operate the KC-135s in support of multi-service, allied and coalition receiver aircraft.

100th Operations Support Squadron
Provides training and support to other US Air Force major commands and NATO allies in the European and African theatres, including all manner of flight operations. The 100th OSS also manages the wing's flying programme and provides the personnel and services to operate RAF Mildenhall on a 24-hour basis.

351st Air Refueling Squadron
Conducts operational aerial refuelling, aeromedical evacuation, airlift and rapid contingency response options for US and NATO fighter, bomber, support and reconnaissance aircraft within the eastern sector of the Atlantic Ocean, across the whole of Europe (except Belarus and Russia), throughout the Mediterranean, much of the Black Sea region, and the safer nations of north Africa.

100th Comptroller Squadron
The chief financial advisor to the 100th Air Refueling Wing and it's $100 million budget for USAFE's aerial refuelling operations, which is part of the $314 million for all activities at Mildenhall.

100th Maintenance Group
Conducts the full spectrum of aircraft and equipment maintenance at RAF Mildenhall.

100th Aircraft Maintenance Squadron
Holds responsibility for sortie generation and maintenance of 15 KC-135 aircraft valued at $1.3 billion, and transient aircraft arriving at RAF Mildenhall.

100th Maintenance Squadron
Performs aircraft, component, and ground maintenance support for resident and transient aircraft.

100th Mission Support Group
Provides base operating support including facilities, civil engineering, communications, vehicles, materiel, and security services.

100th Civil Engineer Squadron
Provides comprehensive civil engineer support to based units, encompassing 1,167 acres, and containing 1,136 base facilities and the 9,206-foot runway.

100th Communications Squadron
Encompasses the entire spectrum of communications, both civilian and military for the entire base.

100th Force Support Squadron
Responsible for a wide variety of support services to all resident and deployed personnel, as well as dependents.

100th Logistics Readiness Squadron
Organises comprehensive logistics to the wing and other resident units, including annual usage of 25 million gallons of JP-8 fuel worth $92 million, and controls $286 million worth of assets including a 570-vehicle fleet. Also provides all travel, cargo, and household goods shipments.

100th Security Forces Squadron
Defends the entire base area, by maintaining 31 mobility ready teams with 243 personnel.

Top: **The 100th Air Refueling Wing regularly supports the 48th Fighter Wing based at nearby RAF Lakenheath. During the 75th D-Day anniversary events and afterward, both wings performed a number of sorties involving their specially marked aircraft.** US Air Force via Bob Archer

Below: **The 100th Air Refueling Wing's flagship aircraft, KC-135R 58-0100 named 100 Proof, was also bedecked with 75th D-Day anniversary markings.** Bob Archer

RAF Mildenhall retains the original aircraft parking dispersals as laid out in World War Two. Whereas most Air Force transportation bases have large concrete aprons, enabling aircraft to be parked in rows, Mildenhall has hard standings which were originally constructed for RAF bombers during World War Two.

One, sometimes two resident KC-135s normally occupy each hard stand, and there are no plans to alter this arrangement at present. During the five years which have elapsed since the closure announcement, there was very little change to the airfield's infrastructure. However, now that the base will remain open, plans are being made for some improvements in the short term, and longer term upgrading is being evaluated. A base spokesperson acknowledged that improvements will be made but was unable to elaborate.

During late September 2020, the 100th Air Refueling Wing participated in Exercise Wolff Pack, a three-day multinational event held around Europe that ended on October 1. The three-day exercise tested the wing's ability to deploy its aircraft to multiple locations around Europe under the agile combat employment construct.

On September 29, 12 resident KC-135s performed a 'baby elephant walk' along the runway in very adverse weather with mist and low cloud nearly thwarting a fairly irregular spectacle. Despite the inclement weather, the 100th's aircraft flew their allocated sorties without any problems throughout the three days.

Understandably the effects of the COVID-19 pandemic have required the entire base to be extra vigilant. Personnel have had to adapt to implementing procedures to minimise the risk, while continuing to perform the mission as required. While COVID-19 has significantly impacted on the base, as it has across the rest of the world, news that the facility will not close has at least offered stability to the wing and other resident units.

Air dominance starts here

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A NEW CREED

Mark Ayton provides an overview of the all-new T-7A Red Hawk trainer destined for US Air Force Flying Training Wings from 2023.

IT'S BEEN A while since the US Air Force took delivery of a new fast-jet trainer aircraft. That event took place at Randolph Air Force Base near San Antonio, Texas on March 17, 1961 when the first example arrived at the Air Force's training super base. The aircraft in question was the then brand new Northrop N-156 model, designated by the Air Force as the T-38 Talon. Between 1961 and 1972, the then Air Training Command received 1,146 Talons. Today, Air Education and Training Command (AETC), the successor to Air Training Command, still operates hundreds of T-38s. Still providing sterling service to the US Air Force, despite the type's age, the T-38 is for the most part no longer best placed to prepare trainee pilots with all of the skills required for high-performance, new-generation fighters like the F-22 Raptor and F-35A Lightning II. Not because AETC's Specialized Undergraduate Pilot Training programme or the T-38 Talon aircraft are deficient, but because the technological gap between a 1950s jet trainer to a new-generation stealth fighter is now too great.

Boeing

Fast forward to September 27, 2018. A big day for Air Education and Training Command. A big day for the Air Force. After decades of procrastination over, and insufficient budget for a new jet trainer, the Air Force announced the joint Boeing-Saab team had won its Advanced Trainer T-X programme. An initial Air Force requirement is for 351 aircraft and 46 ground-based training systems. Delivery of the first production standard aircraft and simulators is a contract commitment for 2023 with an in service date occurring in 2024.

Engineering and Manufacturing Development

Boeing received an initial award of $813.5 million to support the T-X engineering and manufacturing development (EMD) phase involving the delivery of five aircraft and seven flight training systems.

Assuming a buy of 351 aircraft and 46 training systems plus ground support systems, in quantities specified by the Air Force, the T-X programme is estimated to be worth $9.2 billion to Boeing.

Production aircraft are destined for all current Specialized Undergraduate Pilot training units based at Columbus, Mississippi; Laughlin, Texas, and Vance, Oklahoma, and Euro-NATO Joint Jet Pilot Training at Sheppard, Texas.

In the future, additional aircraft and ground-based training systems could be added to the Air Force requirement for up to 475 aircraft.

Boeing of course is predicting much bigger worldwide sales figures for its dashing new trainer. One source suggested 2,000 units, a very ambitious number.

Major Requirements

Boeing's senior director and T-7A chief engineer, Paul Niewald has been with the design team from its start in 2015 and explained the five major requirements specified by the Air Force.

- The trainer had to be safe to fly, longitudinally stable, include the latest fly-by-wire technology and employ a proven engine, the GE F404.
- The trainer had to allow for human cockpit accommodation in accordance with the T-6A Joint Primary Aircraft Training System multivariate cases 1-7, which shaped Boeing's decision to design the T-X with stadium seating to improve instructor pilot visibility for a better training environment.
- The trainer had to have fighter like performance so student pilots selected to fly the F-22, F-35 and future fighters can train with a high-performance experience including high Gs, sustained turn rate, and high angle-of-attack.
- The trainer had to meet high level support requirements with many features and capabilities designed in from the start including drop down avionics' doors for easy access from ground level, a side opening canopy to ease removal of the ejection seats for servicing, fast removal of the engine, a reduced number and types of fasteners in the aircraft, and a fuel system designed with single wall fuel tanks versus fuel bladders.
- The trainer had to allow for growth to enable future upgrades, so all of its systems were developed with open systems architecture and the capacity to increase the amount of weight, fuel and avionics carried.

Paul Niewald confirmed that the Air Force T-X requirements did not include a radar or a helmet-mounted display. He said: "We included a large display for the front and aft cockpits which allows us to adapt different formats for student training needs. We have designed in synthetic capabilities embedded into the aircraft which will be common with the ground-based training system. The software is common. We also have a data link for live constructive connectivity, which will allow bomb drop scoring, target pod training and other advanced student experiences that are important to teach students to effectively operate advanced tactical aircraft."

Providing more details, Boeing's director of the T-X ground-based training systems,

Randy Deidrich said: "We were required to integrate a full range of training systems from the smallest training device to a full motion simulator and all elements in between. The goal: to download and offload training to the lowest, least costly training device for your instructional goals. This makes the systems cost effective and still provides high impact training.

"If you need to train a student to learn the switches you can do that on a desktop device. You can move all the way up to a high-resolution visual system for formation flying, air refuelling and other advanced flight training, and then you can use the aircraft to combine tasks and provide real experience. You can use the best device to achieve your goals for each student.

Above & Left: **These images show the sleek lines of the T-7's fuselage and wing forms. Note the sideward-opening canopy and downward-opening bay doors.** Boeing

"Using one set of software for the aircraft and associated training devices to provide similar visuals and displays solves a concurrent training problem; the simulators look the same as the aircraft. The use of synthetic radar, targeting pod and other advanced level training allow the T-X to better prepare students for the fighter experience by enabling elements to be brought forward into the advanced training phase before they get to the unit level. Radar intercepts, bomb dropping, and gun firing allow students to progress as fast as they can on skill and the number of experiences completed. This will help speed up T-X training time. We have incorporated new training concepts to adjust for those students that have been digital from an early age and can provide a mix of computer-based training and classroom instruction to allow students to learn at their pace."

Elsewhere, a spokesperson for the T-X Program Office at Wright-Patterson Air Force Base, Ohio explained Air Force efforts to speed up pilot training and testing of new training concepts: "Pilot Training Next is a programme to explore and potentially prototype a training environment that integrates various technologies to produce pilots in an accelerated, cost efficient, learning-focused manner. Pilot Training Next will enhance our use of the T-X and make training more efficient and effective."

Above: **Red Hawks with red tails.** Boeing

Advantages

Discussing what he considers to be advantages of the Boeing system, former vice president and program manager of the T-7A Advanced Pilot Training program, Steve Parker said: "We created the T-X to not only meet advanced training capabilities, but also to reduce acquisition and maintenance costs. The majority of the total cost of a military programme is sustainment and operating cost — sometimes up to 70%. Our goal was to drive down these numbers. We had experienced support personnel work with the T-X design team from the start to incorporate supportability lessons into our design for the aircraft as well as training systems."

Discussing future goals, Steve Parker said: "From my perspective we must focus on executing our EMD contract. This is an unusual programme as we made the investment to build and test two T-X aircraft, and the other elements of the training system. Now we are in a test and validation phase. This is not a traditional US Air Force development programme."

Boeing's BTX-1

The aircraft shown in the images illustrating this feature are registered with the Federal Aviation Administration as Boeing model BTX-1 aircraft. They are production representative prototypes of the nascent T-7 and fly on a letter of authorisation with special air worthiness certificates in the experimental category. The two aircraft have civil registrations N381TX (s/n 00001) and N382TX (s/n 00002).

Discussing design aspects of the aircraft, Dan Draeger, chief tactical aircraft test pilot for Boeing test and evaluation said: "There was a lot of emphasis placed on the cockpit design based on Air Force requirements to enable pilots of all physiques to fit in, with the ability to reach and touch the displays, and the need for an almost seamless transition from the ground-based element and the cockpit.

"We designed the aircraft to be pretty much self-sufficient, easy to work on, and be available to fly multiple training sorties with quick turn times to meet aircraft availability and sustainability requirements.

"Once the student pilot and instructor are strapped into their seats, cockpit procedures leading to engine start involve switching the battery on, making a radio call to advise all agencies the crew is preparing for the mission. You then start the APU, verify the mission modes, verify the mission systems are all working, verify the aircraft is, for all intents and purposes, ready to go, check the mission plan is right, then you start the engine, check the flight controls and taxi."

Flight controls are driven by either the APU (the primary means) or dual hydraulic systems (a utility means) and controlled by a triplex fly-by-wire system. Additionally, the APU provides ground power and generates power for the environmental cooling system at any time the engine is not running. The Air Force placed very stringent cool down requirements to provide crew comfort when operating in very hot temperatures regularly endured at all of AETC's bases. According to Dan Draeger, the T-7 has an outstanding ability to cool the cockpit and does so in the required amount of time specified by the Air Force.

Other features include an anti-skid braking system with brake-by-wire control, fully moving stabilisers, dual rudders, and dual trailing edge flaps.

The ability to update simulators at the same time or before the aircraft, was a programme objective. Using open mission systems architecture allows new software to be added without opening up the Operational Flight Program software. This factor reduces the update cycle.

Open mission systems architecture also allowed Boeing to build up the aircraft in blocks. Each block featured more capability. Once flight testing commenced, additional mission system capabilities were added using the same cockpit layout and the same indicators as the cockpit configuration used in production aircraft.

Commenting, Dan Draeger said: "From a flight test perspective, that's unique. Often, we fly with a suite of radios and indicators that won't be in the final configuration because it remains undeveloped. That wasn't the case with this aircraft. We are flying production representative aircraft equipped with production representative mission system suites."

Dan and his colleagues had flown thousands of simulator hours on the aircraft before its maiden flight. He said: "It's what the digital stack allows us to do. We built up a manned simulator, populating it over time with the real systems, boxes, and line replacement units. Thanks to the digital stack we have models of all systems that show us how, for example, the hydraulic system functions when the pilot tries to move the flight controls too fast. In that scenario, the model helps us determine how we change the way the flight controls are used to ensure we don't overdrive the capacity. On a legacy aircraft such a flight control operation would only be determined in flight test. Our objective during the aircraft's entire development was to find such issues before flight tests started. That has meant the T-X flight test programme was a validation effort rather than a discovery effort.

"In terms of the aircraft's flight envelope, we have been to the altitudes, to the speeds, to the slow side of the environment with gear up, gear down. We've dragged this aircraft through the envelope. The goal: to validate subsystems, for instance, to make sure the environmental control system is running properly, heats and cools the cockpit properly, pressurises it properly, and make sure the fuel system delivers fuel in all conditions.

Above: **The T-7A Red Hawk was named in tribute to the US Army Air Corps' Tuskegee Airmen and its P-40 Warhawks and P-51 Mustangs.**

Below: **This image shows the T-7 cockpit layout and the high fidelity of the simulator.** Boeing

"We recently completed inverted flight tests, which involved running the engine in full afterburner at very low altitude while inverted to make sure the tank fed fuel to the engine and had the capacity and the reserves necessary to meet all the requirements.

"For the propulsion system, we've been through the envelope validating what we call the classic chops, snaps and boaties. We've run the engine up to maximum power, down to idle power, abusing the engine if you will, to make sure it's going to operate properly in the environment. We've proven both the spool down and APU assisted air start envelope of the aircraft. We've had no issues whatsoever. All the data collected feeds back into the models and the validation effort for the aircraft's airworthiness."

Dan has been impressed by the aircraft from the moment he took off on its maiden flight. He felt calm because the aircraft performed as expected based on the thousands of hours spent in the manned flight simulator.

As a measure of the aircraft's mission availability, after first flight, the aircraft spent the following day on the ground while the crew and flight test engineers conducted a review. It took to the air again the next day. According to Dan that's almost unheard of for a new type of aircraft. Since then, Boeing's test and evaluation department has flown the same airframe sometimes six times a day to fly all of the test cards issued.

Discussing the aircraft's performance, Dan describes the T-X as a T-38 appreciation ride; everything the T-X is, the T-38 is not. He said: "It's such a smooth and high performance aircraft, yet in the landing pattern it's a docile aircraft with great handling characteristics and touches down nicely every time. It's just a joy to fly up and away and in the landing pattern. The angst involved in teaching young student pilots how to fly and land aircraft, arguably landing is one of the critical phases, is gone. The highest praise goes to the engineers who designed the jet. It is without a doubt an outstanding aircraft."

Above: **The pilot looks left to his wingman in the high-fidelity simulator.** Boeing

Right: **This image shows the all-round visibility afforded to a T-7 crew by the cockpit configuration as a Boeing test pilot looks over his left shoulder in the aft seat.** Boeing

Immersive and Embedded Training

Boeing's fully immersive ground-based training element is designed to prepare a student pilot for real flight in a very

realistic way. Once the student pilot has worked through the entire ground-based system they have effectively flown the aeroplane many times, and because the man-machine interface is extremely intuitive, transition to the aircraft is made much easier. Benefits also extend to the instructor. During a mission, the instructor can mark high or low performance events he or she wants to discuss with the student during the debrief. Back on the ground, the system allows the instructor to quickly scroll to those events for display on the screens.

Debrief methodology is the same for the ground based simulator and the aircraft, and because so much information is captured during the mission, compared to legacy systems, debriefing between the student pilot and the instructor is more effective.

T-7's embedded training element has an ability to modify scenarios in the cockpit. For example, if the student is performing well in a one versus two dog fight, the instructor can change the situation from the aft cockpit, progressing the mission by increasing the number of adversaries using a range of modification tools.

The embedded training system is primarily orientated at tactical training, teaching students the basics of radar intercepts, and bombing with dumb and smart weapons. It runs in both ground based simulators and aircraft.

Tribute

Speaking at the 2019 Air Force Association's Air, Space and Cyber Conference in National Harbor, Maryland on September 16, acting Secretary of the Air Force Matthew Donovan announced that the Boeing T-X trainer had been designated the T-7A Red Hawk. Named in tribute to the US Army Air Corps' Tuskegee Airmen and its Curtiss P-40 Warhawks (1943-1944) and the North American P-51 Mustang (1944-1945).

Programme Status

Discussing the current status of the T-7, Boeing's programme vice president, Chuck Dabundo said the company is in the throes of building two structural test articles, five aircraft and multiple training systems as part of the EMD contract.

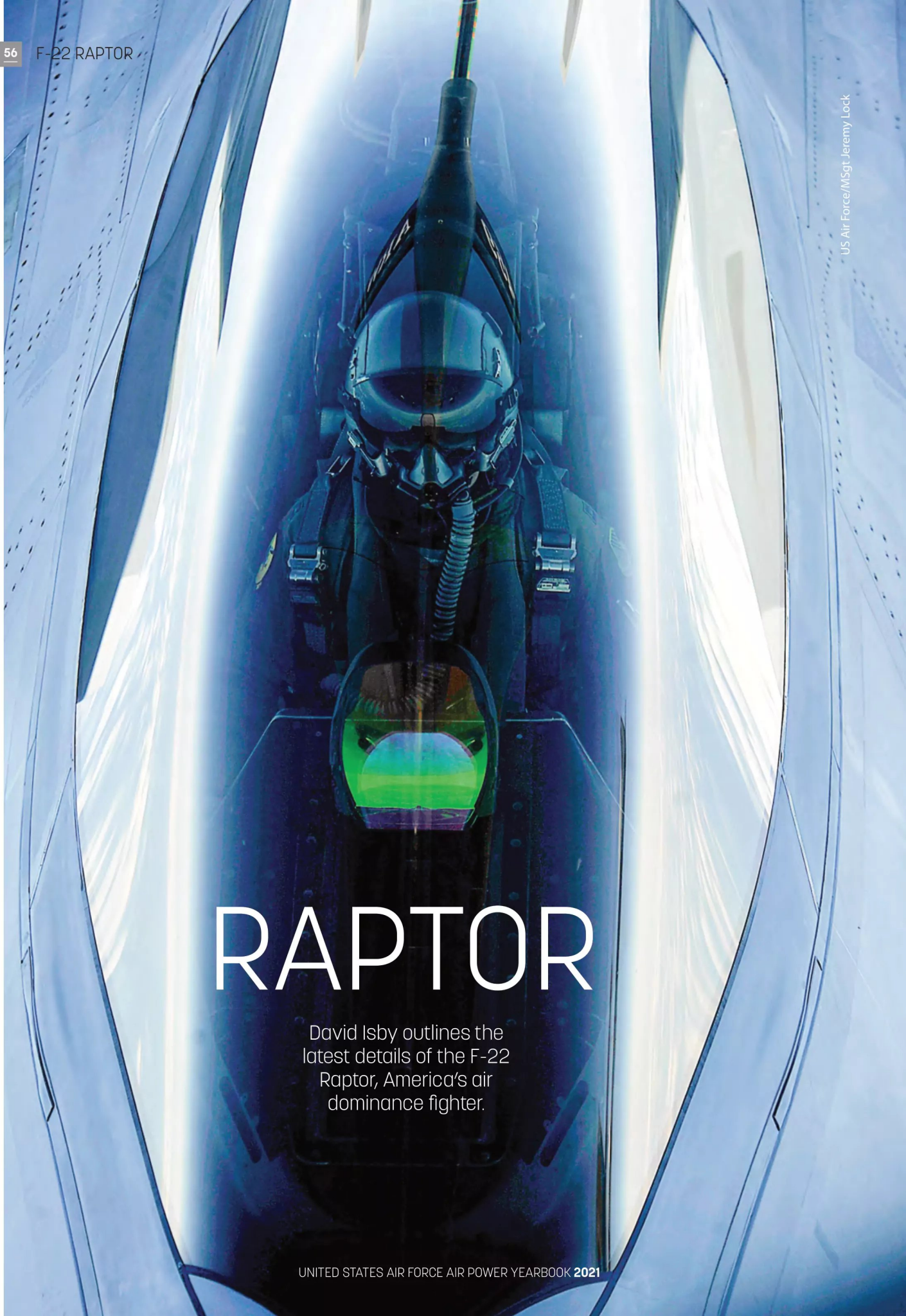
In 2021, the T-7 aircraft will enter its extensive operational test programme with the US Air Force to determine whether it has met the technical requirements of the contract.

Chuck explained how the programme was breaking the norm by leveraging digital engineering and digital manufacturing to the full extent possible and was doing so many months before the contract award in September 2018. He said: "The heart of it is having high-fidelity models of the structure and systems that are fully integrated, and conducting integration electronically, well before we cut chips for black boxes in the lab. It's much more straight forward to make the improvements required to prove the system out and has already paid dividends as we enter the flight test phase of the programme.

Chuck confirmed that N381TX and N382TX are production representative jets but are not identical to the EMD jets currently in production at St Louis, which feature some design changes made in the initial period of the EMD phase. For example, the outer mould line is nearly identical which has allowed Boeing to test flying qualities in all the corners of the envelope and to feed the information back into the digital stack. Data captured during flight testing was used in part as the basis for locking down the final design configuration of the EMD aircraft.

The bulk of EMD flight testing will take place from St Louis-Lambert Field and Edwards Air Force Base, California. Specialised testing will be undertaken at other facilities including the McKinley Climatic Laboratory at Eglin Air Force Base, Florida.

Chuck confirmed that Boeing has received interest from allied nations in its trainer and light attack derivatives of the T-7, that discussions have taken place and some delegations have visited the St Louis facility for programme briefings and simulator demonstrations.



US Air Force/MSgt Jeremy Lock

RAPTOR

David Isby outlines the latest details of the F-22 Raptor, America's air dominance fighter.

ON AUGUST 28, 2020, three two-ship flights of Russian Naval Aviation Tupolev Tu-142 Bear-J aircraft approached the Alaska Air Defense Identification Zone. Lockheed Martin F-22 Raptors from Elmendorf Air Force Base were scrambled to intercept and escort the maritime reconnaissance and anti-submarine warfare aircraft through international airspace. These fifth-generation stealth fighters were, in 2020, on the front line of securing US airspace, acting as a counter to great power competitors.

On June 22, 2020 General James 'Mike' Holmes, outgoing ACC commander, said in a video conference from his headquarters at Langley Air Force Base, Virginia: "Though a legacy system, with a design and stealth technology dating back to the last decade of the Cold War, the F-22 is today the primary specialist air-to-air fighter flown by Air Combat Command."

According to Holmes, structural problems with F-15C Eagle aircraft require the type to be replaced within the current decade, while the F-16C Fighting Falcon has service life left but requires modifications to meet current threats.

For the Lockheed Martin F-35A Lightning II, Holmes said he was: "still figuring out how to sustain the force in an affordable way over the long term." As a result, ACC needs to extract the maximum contribution to US airpower from a finite number – 182 after a May 2020 crash – of F-22s. There is no F-22 attrition reserve.

Readiness

In recent years, readiness of the F-22 force has been stretched by its participation in coalition air operations in the US Central Command area of responsibility. Holmes said: "In 2020, with CENTCOM's demand signal dialled back, this requirement has now been reduced. Now the F-22's focus and primary problem is not having enough aircraft."

In 2018, Hurricane Michael effectively levelled Tyndall Air Force Base in Florida; 17 F-22s had been parked in hangars. The resulting multi-year effort to repair them absorbed sustainment funding and resources. The need to re-base F-22s away from Tyndall – achieved by increasing the primary aircraft inventory of each Raptor-equipped fighter squadron from 20 to 24 aircraft – required spending to accommodate and sustain them. Spares for the F-22's F119-PW-100 engines were in short supply. "We had to work through the issue with Pratt & Whitney," the manufacturers, Holmes said, "we're in pretty good shape now."

Another challenge resulting from the hurricane was the destruction of Tyndall's facility used for renewing F-22 low-observable (LO) coatings. Moving Tyndall-based F-22s to other bases subsequently overloaded their LO facilities.

Aircraft re-assignment required the Air Force to look at a long-term way to improve the maintenance of the coatings, incorporating technology developed in recent decades, while repairing the Tyndall facility and using a contractor-operated facility in Marietta, Georgia as interim solutions.

A 1st Fighter Wing F-22 Raptor from Joint Base Langley-Eustis, Virginia, pulls into position behind a KC-135 Stratotanker prior to aerial refuelling. US Air Force/MSgt Jeremy Lock

America's 125 combat-coded Block 30/Block 35 F-22s achieved a 68% mission-capable rate (the *percentage* of time an aircraft can perform at least one assigned mission) in April 2019.

This figure was up from about 50% force-wide in previous years though the MCR was much higher in deployed units that have additional personnel and resources available.

Then Secretary of Defense James Mattis set a target of an 80% mission-capable rate for multiple types of combat-coded fighters to be achieved by September 2019, including the F-22.

The Air Force has since dropped the goal set by Mattis. In written testimony submitted for his May 7, 2020 confirmation hearing, General Charles Brown, the new Chief of Staff of the Air Force told the Senate Armed Services Committee: "Rather than allocating resources to achieve top-down force-wide mission-capable rates, the Air Force has returned to allowing lead commands to determine the required rates to meet readiness objectives."

F-22 readiness is expensive. In 2013, a Raptor's per-hour flight cost was $68,000 (then-year dollars), over three times that of an F-16. General Brown reminded the senators that "maintaining aging aircraft is an extremely difficult and an expensive task," especially for the F-22, with its complex design and older-generation stealth (the F-35's more advanced stealth technology costs less to maintain). Brown said the F-22 Strategic Sustainment Framework had been established to reduce costs and increase readiness.

Upgrades

The Air Force has evaluated a range of potential upgrades for F-22 sustainment for years, including predictive and capabilities-based maintenance, using artificial intelligence and machine learning approaches.

As a legacy system, the F-22 competes for Air Force resources that could be invested in next-generation technologies. For this reason, Air Force budget requests have never included funding to create a common baseline for the F-22 force, including the 33 Block 20 F-22s currently used for training and research and development. Holmes said: "These older F-22s are not combat capable without bringing them up to the full standard."

Originally, individual upgrades were managed and implemented as part of integral packages such as Implement 3.2A,

Left: **Hot refuelling of an F-22 Raptor at a forward air refuelling point using fuel bladders. This event was one line of training under the agile combat employment concept during the biennial field training exercise Valiant Shield at Andersen Air Force Base.** US Air Force/Senior Airman Michael Murphy

but the Air Force has moved individual upgrades under the Raptor Agile Capability Release (RACR) pipeline: one designed to release capabilities to the field on an annual basis managed as separate but interconnected lines of effort.

RACR is described by the Air Force as: "A vehicle to rapidly prototype and iteratively field critical warfighting enhancements, each using agile software development to deliver incremental capabilities as they mature in months, not years."

RACR was modelled on industry best practices and introduced in 2017 after the Increment 3.2A software upgrade (developed under a standard waterfall strategy) was a year late and over budget.

A primary reason for implementing F-22 upgrades differently, was the long-standing problem encountered with the integration of a helmet-mounted device with the aircraft's existing on board systems while not compromising its stealth characteristics.

Update 6 Interoperability

As with all US tactical aircraft, the F-22 uses computer operating software referred to as its operational flight program (OFP). This product line, dubbed Update 6 (U6) Interoperability, is designed to provide cryptographic updates to all of the F-22's secure links (intra-flight data link, Link 16, and tactical secure voice) to maintain interoperability with Link 16 and secure voice networks. It builds upon the development work already accomplished in a Cryptographic Modernization Program called KOV-20 and integrates that development into a single OFP for fleet release. In addition, U6 Interoperability will correct other software deficiencies previously identified during operations.

U6 comprises an architecture change to accommodate multiple, simultaneous algorithms for Link 16 datalink interoperability and secure ultrahigh frequency radio communications. F-22s currently operate with a receive-only Link 16 datalink. Update 6 also incorporates deferred software corrections carried over from Increment 3.2B.

Update 6 developmental testing began in mid-November 2017 and was expected to be complete in spring of 2020.

During FY2019, U6 Interoperability completed system test and integrated flight test followed by completion of a sufficiency of test review. According to the FY2019 report from the director, operational test and evaluation, that was released on December 20, 2019, the 59th Test and Evaluation Squadron (TES) and the 422nd TES co-located at Nellis Air Force Base, Nevada, and the 411th Flight Test Squadron at Edwards Air Force Base, California, had accomplished over 1,287 hours and 899 sorties on Update 6.

A fielding decision review was expected thereafter followed by the start of fleet release.

Advanced Technology Development (ATD)

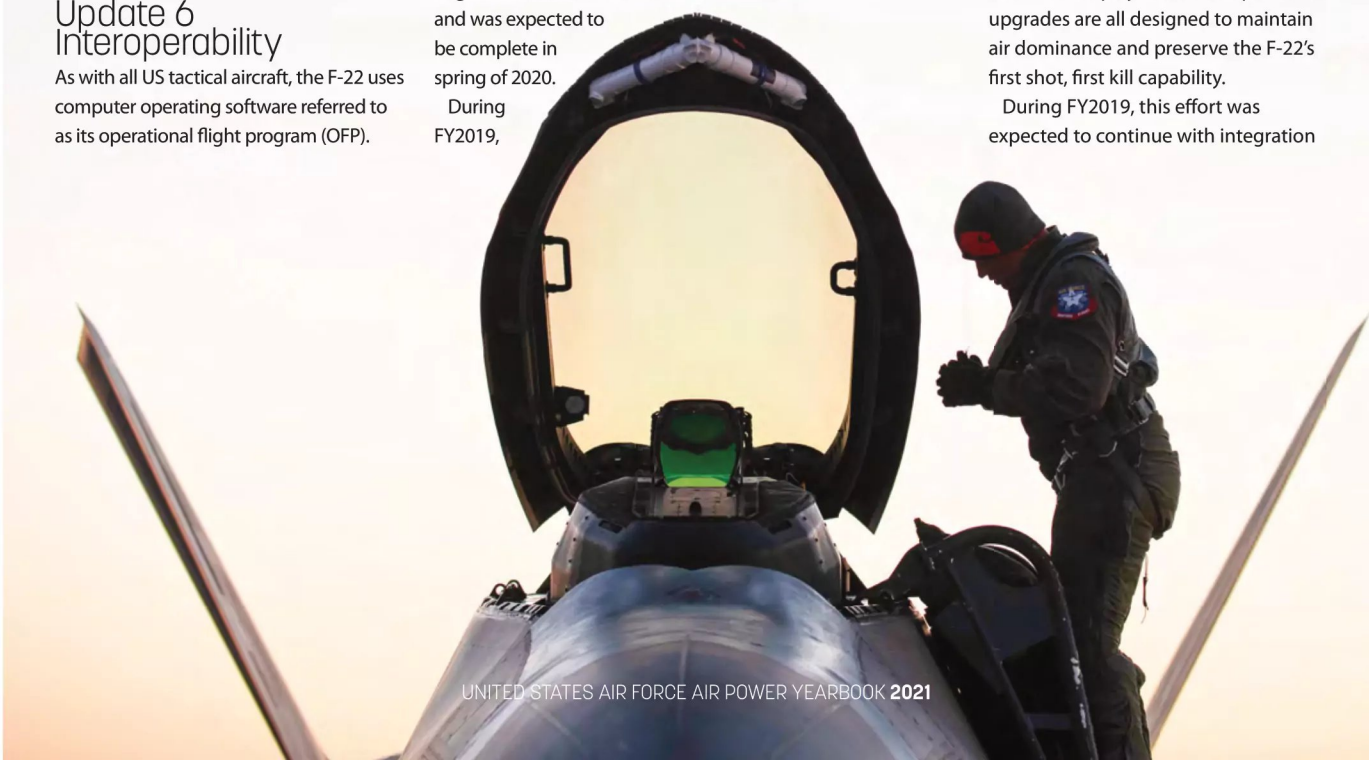
The F-22 ATD Program is conducted using a rapid acquisition construct leveraging commercial best practices such as agility and lean manufacturing to mature technologies, conduct risk reduction studies, and demonstrate prototypes of classified F-22 development efforts. As a consequence, the F-22 Raptor program can develop, test, and field software and hardware from multiple product lines as they mature.

Sensor Enhancements

As part of the F-22 capability pipeline, the sensor enhancements include upgrades to the F-22's on board sensor systems and the software fusion engine that integrates all sensor data to an all-source display on the cockpit. These upgrades are all designed to maintain air dominance and preserve the F-22's first shot, first kill capability.

During FY2019, this effort was expected to continue with integration

Below: **Sunrise over an F-22 Raptor at Sheppard Air Force Base, Texas during a two-day air show in nearby Wichita Falls.** US Air Force/2nd Lt. Sam Eckholm



studies to utilise the results from related ATD efforts as part of assessing the overall technological readiness to support a 2020 fielding decision.

Reliability and Maintainability Program (RAMP)

The RAMP initiative provides for solution identification and integration of modifications to improve reliability, availability and maintainability for the F-22 combined test fleet based at Edwards Air Force Base, California.

An associated RAMP effort funded from the Air Force operations and maintenance budget develops candidate initiatives which are down-selected for implementation and integration based on their level of maturity during development, and their impact on F-22 life cycle costs.

The RAMP solution includes modifications to address corrosion, reduce maintenance hours, increase safety, and provide urgent response requirements to the F-22 fleet.

Plans under the RAMP in FY2019 and FY2020 were to continue retrofit modifications on the combined test fleet aircraft in order to improve system/component reliability, maintainability and reduce F-22 weapon system life cycle costs. Beginning in FY2019, the retrofit modification programme was set to support four operational test aircraft, with the addition of previously stored aircraft being brought into the combined test fleet.

Navigation Systems

The F-22's navigation systems product line consists of the software and hardware development, integration, test, and fielding necessary to ensure the aircraft's ability to maintain Precision, Navigation and Timing (PNT) capabilities, including GPS-degraded environments.

As part of the F-22 capability pipeline, this effort will include the integration of Embedded GPS/INS Modernization (EGI-M) onto the F-22 for M-Code, and replacement of the legacy GPS antenna with a robust Controlled Radiation Pattern Antenna (CRPA), to prevent exploitation of the aircraft by adversaries and provide assured PNT.

This major thrust also captures activities related to integrating the advanced Talon SPITBALL Link 16 antenna onto the F-22.

Plans scheduled for FY2019 included implementation of technical maturation and risk reduction (TMRR) on the F-22 GPS CRPA, and support of efforts for engineering, manufacturing, and development (EMD) of EGI-M in preparation for initial F-22 integration testing. Lastly, support to studies and risk reduction activities for the Talon SPITBALL system.

Plans scheduled for FY2020 included completion of TMRR activities for F-22 GPS CRPA and transition to its EMD. FY2020 activities were also to include system level testing of the CRPA in system labs. To order EGI-M production representative units to support F-22 system and flight test of the EGI-M and transition Talon SPITBALL activities to the F-22 Program Office to continue its development and integration activities.

Northrop Grumman's GPS-Military system passed its critical design review in September 2020. It will provide an assured PNT solution even in GPS-denied environments by integrating M-code encrypted satellite data with an inertial navigation system. Its advanced Talon SPITBALL highly stealthy antennae minimises vulnerability to electronic attack.

Link 16 Transmit

Above: **Note the golden tone of this Raptor's canopy created by a layer of gold and indium tin oxide within the transparency designed to reflect radar waves and solar radiation.** US Air Force/Airman 1st Class Erin Baxter

Right: **Note the patchwork of shades to the low-observable coatings on this Hawaii Air National Guard F-22.** US Air Force/Airman 1st Class Erin Baxter

Formally known as TACLink 16 and part of the F-22 capability pipeline, Link 16 Transmit consists of software and hardware development necessary to field Link 16 Transmit capability on the F-22. The product line will enable the F-22 to transmit tactical information through datalink to both fifth and fourth-generation aircraft and enhance existing receive capabilities.

Once equipped with Link 16 Transmit, the F-22's advanced sensor suite should be able to critically support the situational awareness of all participants in the operational environment.

Link 16 Transmit will be accomplished via an open system architecture integrated with F-22 legacy avionics.

During FY2019, Link 16 Transmit continued EMD and system lab testing, hardware was scheduled to be delivered for fitting in the developmental test (DT) aircraft, and flight testing was due to begin. In FY2020, Link 16 was expected to complete both developmental and operational flight testing.

Mode 5 Identification Friend or Foe (IFF)

Formally known as F-22 Tactical Mandates (TACMAN) and part of the F-22 capability pipeline, Mode 5 IFF consists of software development and the hardware necessary to provide a tactical Mode 5 IFF transponder and interrogation on the aircraft.

This product line also provides an opportunity to incorporate other updates to Link 16 capabilities.

Mode 5 IFF will provide significantly enhanced quality and secure combat identification on all combat-coded Block 30 and Block 35 F-22s.

During FY2019, Mode 5 IFF was expected to continue EMD and ensure production representative hardware delivered to system labs in preparation to start testing of hardware and iterative software releases. Initial product line capabilities packaged under Release 1 entered developmental test. All activities were expected to continue in FY2020 with the start of operational testing.

First tested in 2019, Release 1 was expected to feature increments of TACLink and TACMAN and is scheduled to be fitted to Block 30 and Block 35 F-22s starting in FY2022 and completed within two years. Releases 2 and 3 are also expected to have increments of TACLink and TACMAN to complete fielding of the respective capabilities.

Upgrade Procurement

Critical F-22 upgrades are being procured under the Air Force's Section 804 authority, one that permits an expedited process compared to a full-scale procurement. It aims to reduce both upgrade time and costs across the board: $1.22 billion in the FY2021 budget request was submitted in February 2020, part of a total of $6.3 billion over five years.

The F-22 Reliability, Availability, and Maintainability Program includes integrating the latest Raytheon AIM-120D AMRAAM and Raytheon AIM-9X Block 2 Sidewinder air-to-air missiles, more durable low observable material, structural, and wiring fixes. The F-22 is also considered to be the most likely initial platform for the nascent Lockheed Martin AIM-260 long-range high performance air-to-air missile, with an IOC in FY2023.

The Air Force plans to upgrade 143 F-22s with the Increment 3.2B software, and intends to transition the F-22 to open-mission system (OMS) compliant software, making more rapid upgrading possible, starting with the current sensor fusion upgrade and other lines of effort in the future. OMS software and the associated processor started flight testing on five modified aircraft at Edwards and Nellis in 2019. This capability is planned to be operational by 2021 and fitted fleet-wide within two years.

A Sixth Squadron?

In 2020, Gen Holmes looked at whether ACC could add a sixth squadron of combat-coded F-22s by re-purposing training-coded aircraft. He identified this as a potential benefit from ACC's Rebuilding the Forge (Reforge) programme. Reforge is designed to modernise the fighter pilot training

Above left to right: **A 325th Aircraft Maintenance Squadron weapons load crew carries an AIM-9 Sidewinder missile to an F-22 Raptor.** US Air Force/Samuel King Jr

An Airman reviews a maintenance checklist on a laptop during a weapons load competition held by the 43rd Aircraft Maintenance Squadron. US Air Force/Samuel King Jr

An Airman performs preliminary checks on an F-22 Raptor prior to loading a missile in the weapons bay. US Air Force/Samuel King Jr

pipeline, using the new T-7 Red Hawk trainer with virtual reality, artificial intelligence, and a reorganised training system.

Once implemented, Reforge would shift some flight hours that new fighter pilots currently fly in F-22s to simulators and the T-7A Red Hawk trainer. New F-22 pilots will initially transition to aircraft configured to the same standard as those they will fly on their operational squadron, to "put our newest pilots in the newest aircraft, so they don't have to relearn," Holmes said. This would require fewer F-22s to be allocated to training, releasing the other older Raptors to conduct dissimilar air combat training in a Red air role to augment T-38C Talons. That would meet ACC's need to train against fifth generation aircraft.

Alternatively, the 43rd Fighter Squadron F-22 Formal Training Unit based at Langley Air Force Base, Virginia could be re-purposed as a combat squadron.

Raptor to NGAD

While the Air Force plans to keep the F-22 in service until 2040 and beyond, the service has already evaluated what weapon systems it will require to assure air dominance after the F-22. A requirement necessary in the face of increasing air and ground threats.

Named the Next Generation Air Dominance programme and awkwardly dubbed NGAD, pronounced en-gad, the initiative is being developed as an integrated, yet open-ended suite of systems that can include weapons, expendable, attritable and reusable unmanned air vehicles and at least one manned aircraft. A so-called sixth generation fighter, something the US Navy is currently also at work developing. The NGAD manned fighter is not necessarily intended to be a one-for-one replacement for the F-22, but rather an element of a federated system.

Existence of a classified programme including a manned technology demonstrator for what has become NGAD, had long been suspected.

Dr Will Roper, Assistant Secretary of the Air Force for Acquisition, Technology and Logistics confirmed its existence in a video appearance during the Air Force Association's Virtual Conference on September 14, 2020. Roper said: "The NGAD has broken a lot of [flight] records and is showing digital engineering isn't a fluke. We are ready to go and build the next-generation aircraft in a way that has never happened before."

In 2014, the Air Force first discussed a new X-plane. Soon after, the Defense Advanced Research Projects Agency, launched the Aerospace Innovation Initiative, aimed at flying two X-planes, one for the Air Force and one for the Navy, without any dates. It is not clear whether these efforts led to the NGAD technology demonstrator aircraft.

The manufacturer of the NGAD technology demonstrator aircraft was not announced. Northrop Grumman, with its long-standing experience of stealth and the black world, was thought to be a likely source of such an aircraft. However, Boeing and Lockheed Martin have also been interested and carried out independent research and development programmes that could contribute to NGAD capabilities.

One openly acknowledged NGAD-related technology is propulsion. Over the past few years, the Air Force has invested in variable cycle engines, suggesting Roper was referring to speed records. Use of digital engineering is central to the NGAD programme, with the initial design feeding directly to prototype fabrication and enabling accurate electronic modelling throughout the programme's life. Technologies feeding into the NGAD programme may lead to the production of multiple aircraft types, designed for limited production runs and service lives.

Technology demonstrator, variable cycle engines, digital engineering as maybe, everything depends on the F-22 being able to continue as the Air Force's air dominance fighter until the results of NGAD materialise as aircraft on flight lines or, at least, usable capabilities. It may well prove easier to build such aircraft than for operators to determine the best ways to use them.

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FIGHTIN' 55TH

RC-135 signal intelligence gathering aircraft are some of the oldest in active service. Bob Archer explains the ongoing upgrades designed to keep the jets capable in the face of all emerging threat systems.

ON SEPTEMBER 16, 2020, the United States in conjunction with the United Kingdom performed a rare joint intelligence gathering mission in the Black Sea. A single B-52H Stratofortress operating from RAF Fairford in the UK, permanently assigned to the 5th Bomb Wing based at Minot Air Force Base, North Dakota was involved. The bomber's crew flew its mission profile across the Black Sea, before undertaking a mock attack on the Ukrainian port of Odessa. In the vicinity, were no fewer than five NATO intelligence, surveillance, and reconnaissance (ISR) aircraft monitoring Russian air defence radars, communications, and emitters located in Crimea. Airborne that day was a US Air Force RC-135W Rivet Joint, a RC-135U Combat Sent, a US Navy Boeing P-8A Poseidon maritime surveillance aircraft, and two RAF types; an RC-135W Rivet Joint and a RAF Sentinel R1.

Flying a B-52 so close to Russian territory was guaranteed to cause air defence assets to be placed on alert and to broadcast plenty of communications.

Each NATO aircraft was allocated a different task. The Rivet Joints monitored electronic signals emitted by radars and weapons systems and helped ensure that any Russian air defence fighters launched to investigate the NATO aircraft, showed no hostile intent. Rivet Joints' capability to investigate and evaluate pertinent information in real time was vital to ensure all Russian air defence systems remained passive.

Combat Sent performed its unique capability; scanning all Russian frequencies to interrogate and record all known, but more importantly unknown emitters.

September 16's gathering of NATO ISR systems simultaneously operating in one area forced the Russians to actively use their communication channels.

Combat Sent is equipped with a highly sensitive Precision Power Measurement System (PPMS) for monitoring known emitters. Designed and produced by ITT, the system comprises a suite of sensors mounted around the aircraft and computer processors. Sensors are located in the nose radome beneath the weather radar, on the wingtips, and within a dustbin-shaped fairing extending from the rear fuselage.

With vast banks of information stored in the Combat Sent data bases, sensor operators confirmed and updated known information, such as the location of defence radars and communication facilities.

Using on board direction finding equipment to pinpoint the location of

RC-135V 64-14844 visiting March Air Reserve Base, California fitted with a revised satellite communications cover installed ahead of the tail. Previously an oval shaped fairing housed the Family of Advanced Beyond Line-of-Sight Terminal. The new, prominent satellite communications modification was first observed in December 2019 undergoing tests. Reports at the time suggested the system was not performing effectively. Dan Stijovich via Bob Archer

emitters of interest, the PPMS identified any possible new air defence systems.

Joint operations involving Rivet Joint and a Combat Sent are fairly rare. When joint missions are flown, the pilot crew fly profiles that try and provoke a response from the Russian military. One example involves flying a Rivet Joint at high altitude, performing a series of passes stood-off from, but adjacent to, the location under scrutiny, with Combat Sent flying at a lower level before popping-up within the Russian radar search volume, to unexpectedly appear on their radars, with an element of surprise almost certain to provoke investigation by Russian air defence systems. The long-range battlefield and maritime domains were monitored by the Sentinel and P-8A Poseidon, respectively.

Fightin' 55th

The City of Omaha, Nebraska is one of the largest metropolitan centres in the mid-west of the United States, and home of the Union Pacific Railroad Company. Ten miles to the south of Omaha is Offutt Air Force Base, which is home of the Headquarters of US Strategic Command and the 55th Wing, known as the Fightin' 55th, Air Combat Command's largest wing.

Offutt covers over 4,000 acres of land, a considerable expansion since its original establishment as Fort Crook in 1894. On May 10, 1924, the original airfield was designated Offutt Field in honour of Lieutenant Jarvis J Offutt, Omaha's first air casualty of World War One, killed in France whilst flying with the Royal Flying Corps. From January 1942, Offutt Field was a major production plant of the Glenn L Martin Company which built 531 B-29 Superfortress and 1,585 B-26 Marauders at the facility by the end of World War Two.

Offutt Field became Offutt Air Force Base on January 13, 1948 following the formation of the United States Air Force in September 1947. Its most prominent role commenced on November 9, 1948 with the activation of Headquarters, Strategic Air Command (SAC) which remained resident at Offutt until June 1, 1992 when the command was disestablished.

The Fightin' 55th arrived at Offutt during August 1966 from Forbes Air Force Base Kansas as the then 55th Strategic Reconnaissance Wing, SAC's primary reconnaissance unit. Over 25-years later, on September 1, 1991, the 55th SRW was re-designated as the 55th Wing to reflect the range of reconnaissance and command and control missions undertaken. On June 1, 1992 SAC was disestablished and the 55th SRW was transferred to the new Air Combat Command (ACC).

Today, flight operations are managed by the 55th Operations Group, the largest in ACC with 7,000 personnel assigned between 31 squadrons. The 55th Wing operates a fleet of 39 aircraft consisting of seven different types: two OC-135Ws, three RC-135S models, two RC-135Us, eight RC-135Vs, nine RC-135Ws, three TC-135Ws and one WC-135W reconnaissance aircraft. Additionally, 11 EC-130H electronic combat aircraft are based at Davis-Monthan Air Force Base, Arizona.

The Fightin' 55th has supported every US operation since the end of the Cold War - Southern Watch, Provide Comfort, Vigilant Warrior, Enduring Freedom, Iraqi Freedom, New Dawn, Inherent Resolve (Southwest Asia), Odyssey Dawn (Libya), Provide Promise, Deny Flight, (Bosnia-Herzegovina), Support Democracy, Uphold Democracy (Haiti), Tiger Rescue (Yemen) and Allied Force (Kosovo). **pan**

RC-135s in Europe

European operations by the 55th Wing have centred on RAF Mildenhall, England for the past six decades, with one Rivet Joint usually deployed at any given time. Sorties are currently flown two or three

times each week, usually to the Baltic Sea region to monitor Russian military activities in the Kaliningrad enclave, Russia's westernmost region.

Following dissolution of the Soviet Union, Poland and the three Baltic States of Estonia, Latvia and Lithuania became independent, and subsequently joined the European Union and NATO. The separation from Moscow's control created a division between the vast Russian land mass, and the small enclave of Kaliningrad. Consequently, NATO territory prevented ground access for Russia's military forces to the enclave. Furthermore, Lithuania has a border with Poland, a fellow NATO member meaning Kaliningrad could be encircled by western intelligence, surveillance, and reconnaissance assets at will. Understandably, Russia boosted its military presence in Kaliningrad, and with the traditional unpredictability of President Putin's regime, requires regular monitoring. Should the Russians ever decide to attack westward toward NATO territory, the most obvious land route would be through the vulnerable Suwalki Gap; a 40-mile stretch of land along the Lithuanian-Polish border, with Kaliningrad to the west and Belarus to the east.

Therefore, RC-135s operating from RAF Mildenhall frequently fly racetracks over the Baltic Sea, or above Poland/Lithuania to monitor any Russian troop movements, or increased concentration of forces, which might pose a threat. With direct military action in Syria, coupled with its 2014 annexation of Crimea, and open support of separatists fighting in eastern Ukraine, Putin's track record is questionable.

During August 2020, Belarus staged elections, which outside observers and many Belarusian voters, considered were rigged in favour of the incumbent, and unpopular, President Alexander Lukashenko. Subsequently, Putin has been trying to sign an accord with Lukashenko, strengthening ties between the two, but more importantly for Putin, permitting his troop's access to Belarus, more specifically adjacent the Suwalki Gap.

Consequently, recent Rivet Joint missions have focussed on the region watching for any unusual activity. Whereas satellites can carry out observations on a regular basis, the manned RC-135 has the ability to loiter, and the flexibility to exploit any activity that requires closer scrutiny.

On occasions, Mildenhall RC-135s also perform longer range sorties around the north of Norway to the area of the Barents Sea where a huge concentration of Russian military facilities is located. Most notably, the vast Russian Navy's Northern Fleet, which from a NATO perspective requires regular snoops.

Powerful sensors installed in the Rivet Joint's nose-mounted Automatic Electronic Emitter Location System have the ability to intercept signals emanating from all manner of emitters.

While many facilities are adjacent the Russian coastline, there are ports in Kola Bay like Severomorsk and Murmansk, and air bases on the Kola peninsula. These are front line Russian facilities and are equipped with the latest weapon systems. Understandably, NATO wants to maintain awareness of all Russian capabilities in the region. They provide rich pickings

Forward profile of RC-135U 64-14847 taxing at Mildenhall showing the nose mounted PPMS. Beneath the fuselage are some 30 different antennae which form the MUCELS system. Similarly, the upper surfaces feature yet more antennae for numerous VHF and UHF communication links. Bob Archer

C-135 FLYING SQUADRONS ASSIGNED TO THE 55TH WING

38th Reconnaissance Squadron 'Fighting Hellcats'
The first squadron to move to Offutt in August 1966. Initially it operated SAC's EC-135 Looking Glass mission until April 2, 1970 when the mission was transferred to another unit and the squadron stood down. The then, 38th Strategic Reconnaissance Squadron reactivated on October 26, 1979 as a RC-135 Rivet Joint squadron which it continues to operate today. It was re-designated as a standard Reconnaissance Squadron on September 1, 1991.

45th Reconnaissance Squadron 'Sylvester'
A former RF-4C Phantom squadron (the 45th Tactical Reconnaissance Training Squadron) based at Bergstrom Air Force Base, Texas between April 1, 1982, and September 30, 1989. The 45th was reactivated as a Reconnaissance Squadron at Offutt on July 1, 1994 initially absorbing the RC-135 Cobra Ball and Cobra Eye missions. Over the past ten years the 45th RS has assumed OC-135 Open Skies, TC-135 training and WC-135 Constant Phoenix missions.

82nd Reconnaissance Squadron
Reactivated on October 2, 1991 at Kadena Air Base, Okinawa as a standalone unit assigned to the 55th Operations Group and responsible for RC-135 aircraft and aircrew within the Pacific Air Forces command theatre of operations.

95th Reconnaissance Squadron
Former U-2 squadron assigned to the 17th Reconnaissance Wing based at RAF Alconbury, Cambridgeshire and then the 9th Reconnaissance Wing based at Beale Air Force Base, California until its deactivation on September 15, 1993. The 95th RS was reactivated at RAF Mildenhall, Suffolk on July 1, 1994 as a standalone unit assigned to the 55th Operations Group and responsible for RC-135 aircraft and aircrew within the United States Air Forces Europe command theatre of operations. The squadron also commands Detachment 1 at Naval Support Facility, Souda Bay, Crete.

343rd Reconnaissance Squadron
The original RC-135 Rivet Joint squadron, the 343rd SRS commenced operations in 1967 and continues to fly the aircraft today.

During 2003, the 38th and 343rd Reconnaissance Squadrons became similar operational flying squadrons. Prior to the change, the 343rd RS was a RAVEN (Electronic Warfare Officer) squadron, meaning all 55th Wing RAVENS were assigned to the 343rd. The sister squadron, the 38th RS had all of the Rivet Joint flight crew assigned and was the operational RC-135V, RC-135W squadron. The assets of both squadrons were split and assigned between the 38th and 343rd to enable each to function as a fully operational squadron.

338th Combat Training Squadron
In September 1999, the 338th Combat Training Squadron was activated as a dedicated initial, difference, requalification, and upgrade training squadron for Rivet Joint, Combat Sent, Cobra Ball and Constant Phoenix crew. The squadron manages six different training programmes for reconnaissance, command and control, and treaty verification missions.

Below top to bottom: **A single Rivet Joint carries additional markings for the 55th Wing commander. The tail code is outlined, and the legend 'Fightin' 55th WG' added.** Bob Archer

Both Combat Sent aircraft have sharks mouth markings applied aft of the nose mounted PPMS. According to US Air Force reports, individual PPMS sensors have different capabilities between one another. Bob Archer

for America's RC-135s operating in international airspace in the area.

Twice a year, Mildenhall hosts a short term deployment by one of the two RC-135U Combat Sent aircraft to operate snoop missions in the areas of Kaliningrad and the Barents Sea.

This is not a new strategy. During the Cold War, a Combat Sent aircraft deployed to Mildenhall to monitor spring and autumn troop movements and exercises staged in the western part of the Soviet Union.

Troop rotations in recent times are less scheduled, and not so affected by the harsh weather in northern Russia. Some movements still take place, which need to be analysed by the specialised capabilities of Combat Sent.

Mildenhall-based, the 95th Reconnaissance Squadron is responsible for Detachment 1 at Souda Bay, and forward deploys at least one Rivet Joint to the Crete air base.

During each European deployment, Det 1 usually supports a Combat Sent aircraft for a few days. Unlike Mildenhall operations, those flown from Souda monitor multiple areas including Libya and countries in central Africa. KC-135Rs assigned to the Mildenhall-based 100th Air Refueling Wing, forward deployed to Mediterranean bases, extend the range of Souda-based RC-135s. Such is

the requirement for snoop missions at Souda, the Air Force has activated the 21st Expeditionary Reconnaissance Squadron at the base. The unit coordinates personnel and assets drawn from other locations within a single unit.

RC-135s Across the World

Further east, RC-135 operations at Al Udeid Air Base, Qatar are conducted to monitor activities across the volatile Middle East region, a tasking supported by the 55th Wing since August 1990.

Initially based in Saudi Arabia followed by Al Udeid since 2003, the 379th Air Expeditionary Wing is responsible for all equipment and personnel deployed to the US Central Command area of responsibility. That's an area of the globe containing some unpredictable nations like Afghanistan, Iran and on occasions Pakistan. The 763rd Expeditionary Reconnaissance Squadron flies RC-135 operations across the Middle East region.

Elsewhere, certain countries in eastern Africa, notably those adjacent to the Horn of Africa, are also areas where snoop missions can monitor for terrorist activity, and for Chinese and Russian ventures that increase their spheres of influence around the region.

Kadena Air Base, Okinawa is the other RC-135 operating facility administered by the 82nd Reconnaissance Squadron. Unsurprisingly China, eastern Russia and North Korea are the primary areas for Rivet Joint and Combat Sent operations.

Russia's vast coastline requires regular monitoring, to ensure allied nations Japan and South Korea remain safe, as does the Chinese coast with regard to Taiwan.

Kadena missions tend to be lengthy and are supported by KC-135Rs assigned to the 909th Air Refueling Squadron resident at the Okinawa base.

Explaining the Basics

One slightly confusing aspect of both the Combat Sent and Rivet Joint is the number of official abbreviations used to describe their mission sets.

America's National Security Agency's mission statement says: "The National Security Agency/Central Security Service leads the US government in cryptology that encompasses both SIGINT and information assurance (now referred to as cybersecurity) products and services, and enables computer network operations in order to gain a decision advantage for the nation and our allies under all circumstances."

RC-135W 62-4132 being refuelled by a 100th Air Refueling Wing KC-135R in February 2020. This is essential service to extend the range and mission endurance of an RC-135 operating from Mildenhall when performing lengthy sorties, such as those to the Barents Sea. 100th Air Refueling Wing via Bob Archer

The agency defines SIGINT as intelligence derived from electronic signals and systems used by foreign targets, such as communications systems, radars, and weapons systems. The agency says SIGINT provides a vital window into foreign adversaries' capabilities, actions, and intentions.

For the 55th Wing, the NSA's definition is that of a customer whereas the wing's ultimate command, the US Department of Defense defines SIGINT as: "A category of intelligence comprising either individual or a combination of communications intelligence, electronic intelligence, and foreign instrumentation signals intelligence, derived from communications, electronic, and foreign instrumentation signals."

Intelligence gathering of the kind undertaken by Rivet Joint is a technical topic, but it's easy to unravel.

First off, Rivet Joint is defined as an intercept platform i.e. an aircraft capable

of intercepting signals throughout the electromagnetic spectrum.

On board, the Rivet Joint's mission crew conduct a variety of task that include:

- Target analysis derived by signal detection and direction finding systems
- Using receivers, pre-set to the frequencies generated by a transmitter of interest
- Filtering signals to focus on the most pertinent information transmitted
- Recording the energy level of a particular frequency transmission
- Listening to intelligible signals as part of the COMINT discipline
- Using a spectrum analyser to determine the power of an unknown primary or side band frequency
- Using the data acquired from the spectrum analyser
- for tuning the receivers to the signals of interest
- Undertaking traffic analysis, the discipline of drawing patterns from the information flow between senders and receivers.
- It's also worth explaining the various types of intelligence discussed throughout this feature.
- COMINT is information derived from the interception of messages or voice communications among people that provides information about who is transmitting, their fixed location or in the case of a moving transmitter, a plot of the signal against location, the time and duration of transmission, the frequencies and other technical characteristics of the transmission.
- Gathering of ELINT with electronic sensors is focussed on non-communication signals, more specifically electromagnetic radiations that provide technical and geolocation information.
- Analysis of an acquired signal's parameters helps identification by matching it to criteria held in a database or by recording the data as a new type of emitter. ELINT is primarily focussed on the emissions from an adversary's radars, sensors, weapons control signals, and missile systems of land-based, naval and aircraft including IFF transponders.
- The more technical and analytical MASINT (measurement and SIGINT) discipline tends to focus on unintentionally transmitted information and seeks to detect, track, identify or describe distinctive signatures of fixed and moving sources. MASINT is acquired from different domains within the electromagnetic spectrum, particularly the infrared and magnetic waveforms. Consequently, acquisition necessitates specific sensors.
- Lastly, the RADINT (radar intelligence) discipline involves acquisition of a radar's primary signal using ELINT systems and those of its side lobes using either ELINT or MASINT sensors. It is a method that identifies the type of adversary radar in operation.

Right: **On April 30, 2015, RC-135V 64-14848 caught fire during take-off at Offutt Air Force Base. The pilot skilfully aborted take-off, with all crew escaping safely. Fire damaged the upper surfaces, with the cause traced to a leak in high-pressure oxygen. Allegedly, a nut was incorrectly tightened during planned depot maintenance which started a chain of events that led to the fire. Repair costs were a staggering $62.4 million!** US Air Force/55th Wing

Below left to right: **Sensors are housed within an RC-135's forward fuselage cheeks.** Bob Archer

Seen at Al Udeid Air Base, Qatar, RC-135V 64-14845 with tail markings for the 55th Wing commander. US Air Force/55th Wing

Emblem of the Fightin' 55th and the Nebraska state outline applied to RC-135V 64-14846 seen at RAF Mildenhall. Simon Mortimer via Bob Archer

Combat Sent

America's two RC-135U Combat Sent aircraft have been tailored with differing sensor suites, although the Air Force has been reluctant to specify further. However, the data gathered is critical to the effective design and programming of radar warning receivers, jammers, decoys, anti-radiation missiles, and threat simulators.

Measuring a nation's defensive systems, enables the defence industries of the United States and its allied nations to develop more capable weapons, while their respective armed services can devise tactics and systems to counter the perceived threats.

Gathering technical intelligence, effectively the old fashioned strategic reconnaissance mission first introduced during the 1950s, is the primary task of Combat Sent aircraft.

During the years since the 1950s-era strategic reconnaissance missions, sensor sophistication has improved to an unprecedented level. Current sensors are designed to explore and analyse the frequency, capabilities, and location data of airborne, land-based, and naval radars and emitters. Signals can be acquired manually, automatically, or a combination of both. Data is recorded and stored in the computer databanks at the heart of the aircraft's mission systems.

Primary sensor is the Precision Power Measurement System, although the cheek-mounted Automatic ELINT Emitter Locator System acquires credible

electronic intelligence, similar to Rivet Joint.

Combat Sent provides intelligence analysis at the strategic level and used by America's National Command Authorities (the President, the Secretary of Defense or their deputies) and combatant commanders.

The aircraft utilises radar/solid-state Doppler, INS, GPS, and celestial guidance for ultra-precise navigation, vital when operating close to coastlines or territories of potential adversaries. Any accidental incursion into an adversary's airspace could be catastrophic.

Regular upgrades referred to as baseline standards, ensure the fleet will remain viable through to 2040, possibly beyond. Both RC-135Us have received Baseline 5 modifications, which is similar to the Rivet Joint's Baseline 12 standard (see later). Future viability means ensuring that both aircraft remain capable of detecting the latest and emerging threats. Fortunately, the Air Force has a degree of spending flexibility within its annual budget, allocated to quickly incorporate and enable specific modifications.

Some enhancements involve software updates, which will be installed by contractors at Offutt Air Force Base. Textron Systems is the main systems provider, while L3 Harris Technologies is responsible for all aspects of airframe modifications and upgrades. Minor improvements are carried out at Offutt, while more extensive overhauls and planned depot maintenance are performed at Majors Field in Texas.

Flight deck crew comprises two pilots, two navigators, and three airborne systems engineers. Back end mission crew includes ten electronic warfare officers, six electronic, technical, and mission area specialists and linguists. The latter listen to the adversary's conversations to ensure any hostile intent by the adversary's interceptor pilots are communicated to the flight deck crew immediately. Mission crews vary in size depending on the requirements of the sortie.

Rivet Joint

Two models constitute Rivet Joint: the RC-135V and the RC-135W. Each model was initially fitted with slightly different equipment which distinguished one from the other. Today, those differences have mostly been removed during overhauls and upgrades, yet the two designations are retained largely for hereditary reasons.

Rivet Joint is America's primary signals intelligence or SIGINT gathering system. First fielded in August 1973, additional sensors and external antennae have gradually altered the aircraft's appearance and provided a vast improvement in capability. Faster computers combined with sensor miniaturisation have appreciably enhanced the system's acquisition capacity.

As a weapon system, Rivet Joint's primary task is to gather real-time signals and electronic intelligence, then analyse and disseminate the data for use by theatre and strategic-level commanders.

Rivet Joint aircraft are configured with large modifications to the forward fuselage known as "cheeks" which house antennae for the two main intelligence gathering systems dubbed AEELS and MUCELS, both at the heart of the Rivet Joint system. The AEELS abbreviation refers to the Automatic ELINT Emitter Locator System and MUCELS refers to the Multiple position COMINT Emitter Location System.

Both AEELS and MUCELS rapidly scan emitters to search, detect, measure frequency, identify type, separate from the source, determine location, and fuse the data acquired. Time sensitive information can be relayed to combatant commanders. In particular, Rivet Joint can monitor hostile interceptor jets likely to be a threat to allied aircraft and relay an appropriate message to all relevant forces.

Rivet Joint Systems

The RC-135 Rivet Joint cheek fairings house some of the primary ELINT side-facing antennas integrated with the Automatic ELINT Emitter Locator System. To undertake the full SIGINT mission, Rivet Joint needs the capability to collect signals from across the entire electromagnetic spectrum. AEELS is the primary system used to gather those signals, process them, and filter out the most significant and interesting. Selected signals are then served to the on board operator stations

Above: **Two ground technicians prepare RC-135V 64-14844 for a mission on a cold winter's day in 2016. The forward edge of the chipmunk cheeks is readily apparent.** US Air Force/55th Wing via Bob Archer

Below: **RC-135V 63-9792 outside one of the hangars at Offutt Air Force Base. Note the engine covers are individually marked with the aircraft's serial number and the aircraft maintenance squadron emblem.** US Air Force/55th Wing via Bob Archer

for analysis by the system operators. Mission data is recorded on computer hard drives.

In 1976, the first Rivet Joint aircraft, RC-135V 64-14848, was fitted with the fully automated MUltiple position COMINT Emitter Location System (MUCELS), which is a standard system throughout the fleet used to collect communication intelligence across a wide frequency band. The most visible component of the MUCELS system is the 'antenna farm' of large plate aerials, on the fuselage underside.

All Rivet Joints have satellite communication links, which are facilitated by seven T-shaped aerials fitted on the top of the fuselage.

There are few external differences between the RC-135V and RC-135W, the W-model does however have longer fairings than the RC-135V.

Rivet Joint is a platform with a lot of communication capability. Perhaps the most significant installed is the Tactical Digital Information Link (TADIL/A), which enables Rivet Joint to transfer the collated and refined ELINT data to E-3 AWACS aircraft airborne in the theatre of operations. On board satellite links enable the ELINT data to be transferred to national chain of command users or onto the near real-time Tactical Information Broadcast Service for use by theatre commanders.

Above: **Period image of RC-135W 62-4139 refuelling from a KC-135R assigned to the Hawaii Air National Guard over a barren Middle Eastern landscape.** US Air Force via Bob Archer

Below: **Nose-mounted PPMS is clearly visible on RC-135U 64-14847 seen at Wright-Patterson Air Force Base, Ohio in December 2019. The Combat Sent was flown to the base to allow personnel who work for the program office to tour an aircraft they support.** US Air Force via Bob Archer

One of the most noticeable additions to each reworked RC-135 during the 2000s is a circular communication antenna on the top of the fin. The antenna uplinks ELINT data to satellites for combat advisory broadcast and threat warnings and is believed to be part of the TADIL/A system.

One of the most striking, yet reassuring instruments carried by the RC-135 is the sextant, which is used as a manual back-up for navigational purposes. It is regularly used during flights crossing the Atlantic and Pacific oceans. The aircraft has a sextant port located in the top of the cabin above the navigator's position.

Rivet Joint Mission Crew

Of all variants of C-135s that have served with the United States Air Force, the RC-135 Rivet Joint is perhaps the most distinctive with its extended thimble nose and slab-sided cheek fairings.

The 38th and 343rd Reconnaissance Squadrons operate the RC-135 Rivet Joint fleet at Offutt Air Force Base to provide near real-time ELINT and COMINT collection, analysis and dissemination capabilities to combatant commanders and national chain of command authorities.

In the tactical role, the aircraft provide commanders with imminent threat and time-sensitive information about the location and intent of enemy forces. A role employed extensively in Iraq and Afghanistan. Rivet Joint's capability to broadcast combat advisory information and threat warnings to aircraft in danger elevated the tactical mission to one with the highest priority.

The aircraft can carry a maximum of 35 passengers which includes an augmented crew including a pilot, navigator, two crew chiefs and maintenance personnel though numbers and permutations of crew vary.

The RC-135 Rivet Joint is divided into three compartments; the flight deck; the RAVEN compartment which is the forward reconnaissance section used for the ELINT mission; and the Operators compartment which is the aft reconnaissance section used for the COMINT mission.

RAVENS are Electronic Warfare officers who operate the AEELS (Automatic ELINT Emitter Locator System) suite and the manually operated direction-finding antenna. The RAVEN compartment has three consoles designated RAVEN 1, 2 and 3 - RAVEN 3 is the forward console. RAVEN 1 runs the AEELS automatic collection system; RAVEN 2 (the mid console) hosts the tactical co-ordinator - the orchestrator for both the ELINT and COMINT operators and RAVEN 3 runs the manual collection system.

All of the intercepted signals data is retained and can be sent to a CAOC via satellite, datalink, and radio

communications. This data transfer capability makes the Rivet Joint a near real time data provider to a CAOC.

Each RAVEN console has an upper and lower BARCO screen. The upper screen has a map display for situational awareness used to identify potential hostiles. The lower screen is used to interface between systems and monitor the ELINT equipment.

The RAVEN computer system integrates the ELINT data collected to complete the Rivet Joint mission.

The two forward operator stations are used by Airborne System Engineers (ASEs) who monitor and troubleshoot all the mission systems and undertake light maintenance i.e. the ASEs change components sourced from the spares store located at the aft of the operator's compartment. The ASEs are involved with all aspects of the mission keeping the systems running to enable the complete mission to go, one ASE is dedicated to the ELINT systems and the other to the COMINT systems.

There are a further 17 operator stations in the aft operator's compartment. The first five stations are used by system management operators who control the data flow coming into Rivet Joint from the various sensors and the data sent out of the aircraft via the various communication links. The middle station is occupied by the Airborne Mission Supervisor who controls the communications team and liaises with RAVEN 2. Of the 12 back-end stations, the first is occupied by the datalink operator, who maintains contact with airborne E-3 AWACs and E-8 Joint STARS. The remaining eleven stations are all used by system operators, many of which are linguists, two of whom are signals specialists.

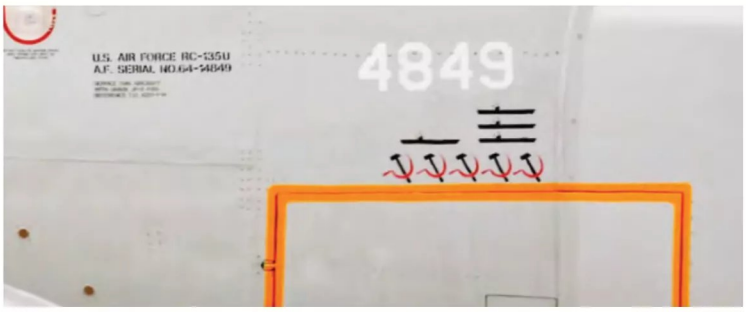
Baseline Standards

Rivet Joint receives continuous baseline upgrades to keep the fleet viable through to 2040 and has flexible funding to provide for rapid modifications to counter any evolving requirements, just like the RC-135U.

Nearly all of Offutt's fleet of 17 Rivet Joints have completed the Baseline 11 subsystem upgrade. The mission crew get ELINT recorder expansion, integration of precision ELINT and digital SIGINT systems, improved operator interface and reporting tools, and enhanced capabilities in dense signal environments. Pilots benefit from an updated flight deck featuring an improved weather radar, digital instruments, and a communications, navigation, and surveillance system for air traffic management, dubbed CNS/ATM for compliance with global air traffic management protocol. Collectively, the flight deck updates make up the Baseline-C configuration destined for all Offutt-based C-135 series aircraft, which also includes RC-135S Cobra Ball, and TC-135 Rivet Joint trainer aircraft.

Integration of Baseline 12 has started. The crew (flight deck and mission) get improved signal acquisition in dense electronic traffic environments, increased digital signal exploitation capability, increased digital signal recorder bandwidth, enhanced spatial processing and exploitation, a digitally enhanced electronic flight instrument system, operator work station 3-D map projection, enhanced operator reporting management tools, modernized communications security protocols, and

RC-135W 62-4139 behind its tanker aircraft after aerial refuelling. US Air Force via Bob Archer



new steerable beam antenna. Baseline 12 also includes integration of the Distributed Common Ground Stations (DCGS). The Air Force DCGS, designated the GSQ-272 Sentinel weapons system, is the primary ISR planning, direction, collection, processing, and distribution network. It links 27 download centres used by all Air Force ISR systems run by the 480th Intelligence, Surveillance and Reconnaissance Wing, headquartered at Joint Base Langley-Eustis, Virginia.

Funding in the FY2020 budget focusses on completing Baseline 11 and Baseline 12 configurations and launching Baseline 13. The latter upgrades include providing a continuous recording capability, super wideband compressive receiver and Nyquist folding receiver, new autopilot, Mode 5 IFF system, a family of beyond-line-of-sight terminals, and an advanced extremely high frequency communications suite. The Nyquist receiver supports the process of digitizing analogue signals named after a principle called the Nyquist Theorem or sampling theorem.

Top right: **Rarely do 55th Wing aircraft carry mission markings, especially to denote the type of target being evaluated. In September 2014, RC-135U 64-14849 flew several sorties to the Barents Sea area. Subsequently, five hammer and sickle, and four aircraft carrier zaps were applied to the aircraft's forward fuselage. During its deployment to Mildenhall, the RC-135U had monitored Russia's Admiral Kuznetsov aircraft carrier during sea trials post-overhaul at the Severodvinsk Sevmash shipyard.** Bob Archer

Right: **This image is believed to be inside a Rivet Joint during a mission over the Middle East showing the close proximity of sensor operators in the aft cabin.** US Air Force via Bob Archer

Rivet Joints have a flight crew of three pilots and two navigators, while the back end mission crew comprises three EWOs, 14 ISOs, four airborne maintenance technicians, and linguists. On at least three occasions when linguists were monitoring adversary communications, they were able to provide timely warning to enable the Rivet Joint pilot to execute evasive tactics and vacate the area to prevent a catastrophic incident.

Ageing Fleet

The entire RC-135 fleet of aircraft were originally built between May 1962 and February 1965. Despite their age, as of September 2019, the two RC-135Us had a mission capable rate of 91.07%, the RC135Vs 74.10%, and RC-135Ws 69.49%.

There are no plans to replace the fleet at present. Furthermore, the Air Force anticipates its RC-135s will continue in operational service until at least 2040. By that time, all of the aircraft will be 75 years or more old. An amazing and intriguing prospect for an aircraft equipped with cutting edge technology, employed to acquire secrets of the Western world's adversaries, in some of the oldest airframes in the Air Force!

Evaluation of the recapitalization of its RC-135 fleet continues. Testifying to a House Armed Services Committee on April 2, 2019 about reconnaissance fleet funding, the then Air Force Chief of Staff General David Goldfein said: "The same work that we're doing in Advanced Battle Management Systems, as we look at what the replacement for Joint STARS is going to be, we're looking at all of these capabilities—the ones that right now are more platform-centric."

It was perhaps a reference to Rivet Joint, Combat Sent and Cobra Ball being replaced with a network of sensors and satellites instead of new aircraft dedicated to the various missions. A re-capitalization programme for the E-8C JSTARS was cancelled in 2018 because of concerns about the shoot down vulnerability of a large new battle-management aircraft. Goldfein's comment implies the Air Force is at least considering incorporating the respective missions of Rivet Joint, Combat Sent and Cobra Ball into a distributed network of sensors. He also told the hearing: "It was a significant move for the Air Force to shift from a platform solution on battle management [the E-8C] to a network solution going forward. Our future in the business of joint warfighting is to ensure that we're taking every sensor and every shooter and connecting them together … to overwhelm an adversary."

COBRA

NONE OF THE 55th Wing's jets are more unique and more specialised than its three RC-135S Cobra Ball telemetry intelligence (TELINT) aircraft. The type is flown by the Offutt Air Force Base 45th Reconnaissance Squadron.

Cobra Ball's unique mission was originally used to monitor Soviet missile activity during the Cold War. Back then, Cobra Ball operated from bases in the western Pacific, primarily Eareckson Air Force Base, Shemya in Alaska, to collect signature telemetry data of Soviet ballistic missiles and missile re-entry vehicles launched on test. The data collected was analysed to determine the capabilities of each particular missile.

In the post-Cold War world, Cobra Ball continues to be tasked by the Joint Chiefs of Staff in the TELINT role to collect optical and electronic data from tracking ballistic missile systems and re-entry vehicles for treaty verification in what are termed 'Rest-of-World activities', China, India, and Pakistan for example. Cobra Ball is also tasked with spotting battlefield missiles, in the so-called theatre missile defence role. The latter role having been adopted in response to the Scud missile threat faced during Operation Desert Storm in 1991.

A Cobra Ball flight crew consists of two pilots and two navigators, the mission crew comprises five electronic warfare officers, two in-flight maintenance technicians and six other mission specialists, many of whom are also qualified for the Rivet Joint and Combat Sent missions.

Each RC-135S is configured with a thimble nose, cheek fairings housing electronic receivers and an aft fuselage teardrop-shaped antenna fairing. The RC-135S nose houses an enhanced weather radar used to provide very accurate positional data to the crew, which ensures that during TELINT missions, the crew stay within international airspace. The Cobra Ball radar has a very effective tracking capability, which is used to detect missiles, cruise missiles or aircraft in the Theater Missile Defence role. The radar tracks the target and provides positional data in a three-dimensional mode in all weather conditions.

The most notable modifications on a RC-135S are large circular windows in the starboard fuselage. These facilitate telescopic monitoring devices, advanced optics and infrared telescopes and

Cobra Ball RC-135S 62-4128 seen shortly after take-off from Offutt Air Force Base. Notable are the matt back right wing and engine cowlings applied to help reduce sun glare for the aircraft's tracking cameras.
Dan Stijovich

BALL

Mark Ayton details the highly specialised RC-135S Cobra Ball.

sensors used for tracking ballistic-missile tests at long range to provide missile treaty verification data and theatre air defence warning.

The two original Cobra Ball aircraft, 61-2662 and 61-2663, are equipped with the full signals intelligence (SIGINT) and measurement and signatures intelligence (MASINT) sensor suites to gather intelligence data from the entire electromagnetic spectrum. Two sided electro-optical/infrared radiometric sensors, infrared telescopes, and spectral sensors called the Real Time Optical System (RTOS) and the Large Aperture Tracker System (LATS) form the MASINT sensor suite. RTOS is a long-range sensor system, which can acquire, track and record targets in the visible and infrared spectrums. The RTOS staring sensors centred off the wings provide a target acquisition capability with a 120° arc on both sides of the aircraft. LATS is an optical telescope, which captures long-range targets in fine-resolution imagery with its 12-inch focal length.

Cobra Ball is also equipped with the Medium-wave InfraRed Array (MIRA) optical surveillance sensor (camera) system. MIRA cameras, fitted on both sides of the aircraft, capture missile re-entry imagery within the medium wave infrared spectrum. The MIRA system provides Cobra Ball with an advanced scientific and technical intelligence collection capability used for foreign ballistic missile system analysis and treaty verification.

Cobra Ball aircraft have received Joint Tactical Information Distribution System datalinks and real-time datalink transfer systems which link the aircraft with the Rivet Joint fleet. The datalinks were installed in Cobra Ball for its Theater Missile Defence role to provide theatre commanders with real-time missile threat information.

A third RC-135S, 62-4128 entered service with the 45th Reconnaissance Squadron in 1998 and is referred to as Cobra Ball II.

By 2007, all three Cobra Ball aircraft were equipped with an upgraded fully-missionised sensor suite, standard Rivet Joint communication links, and a high-bandwidth fibre-optic data distribution system. The Cobra Ball fleet was the final RC-135 model to receive the Pacer Crag glass cockpit and F108 engines.

B-21 RAIDER: NEW-GENERATION STEALTH BOMBER

David Isby details America's nascent B-21 Raider stealth bomber.

"IT'S STARTING TO look like an aeroplane," said Randy Walden, head of the US Air Force Rapid Capabilities Office (RCO). Walden is one of the few people briefed on what is happening inside the secure Plant 42 at Northrop Grumman's Palmdale, California factory. Walden's RCO is responsible for managing the highly-classified special access programme. Part of what is referred to as the black world of activities not openly discussed or often, even revealed. Appearing on an August 13, 2020 video conference, Walden said: "Suppliers from across the country are delivering parts. It's coming together now."

Behind closed doors, the first B-21 bomber is being built at Palmdale. If major components have come together, that suggests the new stealth bomber has already passed its production readiness review, required to authorise construction.

Putting Wheels on The Apron

"Don't hold me to it, but it's something like 863 days to first flight," said Air Force Vice Chief of Staff General Stephen Wilson in July 2019. That puts the great day in December 2021. Other generals have since hedged their bets. Appearing on an August 31 video conference, commander Eighth Air Force, Major General Mark Weatherington said: "We expect first flight somewhere in 2022, no earlier."

While no timeline has been announced, the 420th Flight Test Squadron, reactivated at Edwards Air Force Base, California in 2019, has been designated as the B-21 Combined Test Force, and is preparing to lead the testing.

The B-21's systems have already been ground tested and flight testing has started on a modified surrogate testbed aircraft, reportedly a civil-registered Boeing 737.

A non-flying prototype has also been built at Plant 42 to correct full-scale system integration issues.

Work on software has also progressed. The B-21 design includes open system architecture and containerised software, produced using Kubernetes tools developed by Google. Kubernetes is an open-source system for automating deployment, scaling, and management of containerised applications. Containerised software allows upgrades to be integrated but without affecting the millions of lines of software code required to make the B-21 function.

Above: **An artist's rendering of a B-21 Raider stealth bomber released by the US Air Force. The nascent aircraft, yet to be seen for real, might well look different to the aircraft depicted in this image.** US Air Force

If no setbacks are encountered, B-21 low rate initial production (LRIP) could start during FY2023-24, with initial operational capability (IOC) following within three years. Its production rate could ramp up to 12-14 aircraft per year once the bomber enters full rate production (FRP). The programme of record remains for 100 aircraft, though multiple studies have identified that an expanded bomber force is needed to meet changing US defence planning and priorities, especially for east Asia and the Pacific Rim.

"Programmes will always have a few surprises early on, and the B-21 won't be any different. I know we're not going to be immune from design flaws," Walden said, "we're going to have to work through those."

The B-21 programme schedule – and the big ticket requirement that production aircraft meet a fly-away cost of no more than $550 million (in FY2010 dollars) – is challenging. Some of the B-21 subcontractors, Walden said, had experienced delays imposed by the COVID-19 pandemic.

Wichita-based Spirit Aero Systems used Defense Production Act funding to repurpose some of its production facility for the B-21. Before the pandemic, the facility was used to produce composite structures for the Boeing 737 MAX.

"So far, we think the programme is on track, coming in under or at the unit cost we thought it would come in at, which is great. We think it's going to deliver the capabilities because we have a strong set of requirements that underpin it," said Weatherington.

Reportedly only the Air Force chief of staff is authorised to change B-21 requirements to prevent a 'requirements creep' caused by moving goalposts and requiring expensive and time-consuming changes; the chalice for many Department of Defense programmes.

What's Coming?

The day when a B-21's wheels are on a flight line is getting closer, but the landing gear and the aircraft they are going to be attached to is still largely left to your imagination.

B-21 illustrations released by the Air Force are to date generally too low in resolution to be used in a printed version but show a smaller, modified version of the B-2 stealth bomber, indicating it is intended to conduct similar missions flying at high-altitude for precision weapons delivery.

In 2019, head of Northrop Grumman's aerospace sector, Janis Pamiljans was quoted in the press as saying: "What we learned on B-2 are baselined in the design of the B-21 for the purposes of supportability, sustainability, and mission capable rate. Where the B-2 goes, so goes B-21."

Further analysis of the illustrations released show each main landing gear unit has two wheels, rather than four as per the B-2 which suggests a lower max take-off weight and a smaller size.

But those illustrations also show that the B-21 design may not incorporate some of the features that were added to the B-2 to improve low-altitude penetration capability back in the 1980s, most notably the characteristic saw tooth trailing edge design. A less-complex wing design may provide the B-21 with better high altitude performance and reduce production costs.

Additionally, the illustrations show the B-21 design includes blended engine nacelles and nearly-flush engine intakes, features that are desirable for stealth, although their incorporation has been limited by difficulties in assuring airflow and in the cost of fabrication.

One fact that has emerged about the B-21 involves the intake and exhaust designs. They proved challenging according to ranking member with the House Armed Services' Seapower and Projection Forces Subcommittee, Rob Wittman, Republican-Virginia who said when speaking to reporters after a speech at the McAleese-Credit Suisse defence conference held in Washington on March 6, 2018: "This is a very, very different design [to the B-2] as far as airflow, and there have been some design challenges there."

The B-21 may also benefit from improvements in fabrication and production technologies. For example, Boeing's MQ-25 Stingray unmanned aerial vehicle tanker for the US Navy has a flush air inlet design, even though its requirement documents did not call for stealth but did specify the minimisation of production and sustainment costs. New technologies make the use of such design elements less expensive, in both design time and cost terms.

Main Picture & Far Right: **An EC-130J from the 193rd Special Operations Wing based at Harrisburg; Pennsylvania approaches the boom of the tanker during aerial refuelling.** US Air National Guard/Senior Airman Zoe Wockenfuss

COMMANDO SOLO

David Isby provides insight into America's primary aircraft designed for military information support operations, the EC-130J.

WITH AIR DISPLAYS cancelled worldwide in 2020 because of the COVID-19 pandemic, their place was taken by flyovers to honour those fighting the disease. Pennsylvania Air National Guard participation included flying its unique version of the classic Hercules: the EC-130J Commando Solo II, an aircraft assigned to Air Force Special Operations Command (AFSOC) and US Special Operations Command (SOCOM).

Information Ops

For the seven EC-130Js operated by the 193rd Special Operations Wing (SOW) based at Harrisburg International Airport, Pennsylvania – the only Air National Guard wing in AFSOC – flyovers represented a change from their usual mission.

Airborne broadcasts are the EC-130J's primary – though no longer only – mission, used for psychological operations (PsyOps), information operations (IO) or civil affairs (CA). Today, all three activities are now included in the broader military information support operations (MISO) mission.

Flight deck crew comprises a pilot and co-pilot, and the mission crew comprises a combat systems officer, a mission crew supervisor, three electronic communications systems operators and two loadmasters. The aircraft's aft cabin comprises a mission system control compartment with four operator stations, and at least one mission systems compartment fitted with racks of control and mission system boxes.

An EC-130J can transmit to cell phones, televisions (with over 10,000W broadcast power), AM/FM and short wave radios, military communications, and provide internet and communications connectivity where both services have been denied by adversarial activity.

Using pod-mounted systems, EC-130Js are capable of conducting electronic warfare (EW), electronic attack (EA) and, potentially, cyber-attack missions.

In recent years, EC-130Js have already carried out deployments to substitute Air Combat Command EC-130H Compass Call aircraft, the first example of which has been retired.

For years, Pennsylvania Air National Guard's 193rd SOW is believed to have had aircraft deployed to the US Central Command area of responsibility more often than any other Air National Guard unit. The wing flew its first mission transmitting radio broadcasts on October 5, 2001, two days before the start of coalition military operations in Afghanistan. Over the subsequent months, two 193rd EC-130E Commando Solo aircraft flew 307 sorties broadcasting messages to the Afghan population and Taliban soldiers in support of Operation Enduring Freedom with a 100% mission success rate.

In 2010, EC-130Js participated in humanitarian relief operations. A three-aircraft deployment to Haiti provided much needed broadcast capability following the catastrophic earthquake that killed 220,000 people. Broadcasting pre-recorded Haitian Creole messages over AM and FM radio channels, the EC-130Js provided essential information about emergency aid distribution.

Below: **This image of EC-130J 99-1932 clearly shows the positions of the aircraft's various antennas housed in the outboard underwing pylon-mounted pods for electronic warfare, oversized underwing blade antenna, and the so-called X-antenna mounted on both sides of the fin.** US Air National Guard/ Munnaf Joarder

Penn State's EC-130Js have also been used to transport relief supplies and communications equipment, as they did after Hurricane Harvey made landfall over Texas in 2017.

More recently, EC-130Js were launched from Naval Air Station Sigonella, Sicily, heading for international airspace off the coast of Libya. Their role, to broadcast PsyOps' messages over Libya.

Single ship EC-130J missions are the norm, flown above 20,000ft to provide offset and increase the transmission range beyond 150 miles. That's an improvement over the EC-130E which, at the start of Operation Iraqi Freedom in 2003, could not reach the television audience in Baghdad. Unlike its predecessor, the EC-130J has aerial refuelling capability.

Upgrades

Four of the seven EC-130Js assigned to the 193rd SOW are Super J configured aircraft, capable of SOF-FLEX (special operations flexible) mobility missions, as tasked by SOCOM.

SOF-FLEX includes personnel and cargo airdrop, combat offload, and infiltration/ exfiltration capabilities. The four aircraft retain an EW/EA capability and are able to broadcast AM/FM and shortwave radio, but currently lack the television broadcast capability of the other three aircraft, a fact reflected by their antenna arrays.

Upgrading EC-130Js is the responsibility of SOCOM's Program Executive Office for fixed wing aviation, the organisation that handles AFSOC's other types of special mission Hercules. This includes the Block 8.1 upgrade currently in production, a standard that delivers new communication and data link capabilities, and a modern flight management system.

A satellite communication system dubbed the Mobile User Objective System (MUOS), and GPS hardening are two further upgrades bound for Penn State's EC-130Js, upgrades being installed throughout the Hercules fleet.

Additionally, the EC-130Js will be retrofitted with the Northrop Grumman AAQ-24 Block 30 Large Aircraft Infrared Countermeasures (LAIRCM) system by FY2021, though installation of Link 16 datalinks has been proposed but not yet funded.

Right: **EC-130J 99-1932 taxies out on a mission at the 193rd Special Operations Wing's base at Harrisburg Airport Pennsylvania.** US Air National Guard/ SSgt Tony Harp

Middle Right: **A clear angle showing the so-called X-antenna configuration mounted on both sides of the fin. These are used for civil affairs broadcasts in AM, FM, HF, TV, and military communication bands.** US Air Force/ Airman 1st Class Dennis Spain

Below: **Inside the mission systems control compartment of an EC-130J showing two of the four operator stations.** US Air National Guard/SSgt Elizabeth Rissmiller

Bottom: **A guardsman keys an input to one of the numerous mission system boxes housed in the mission systems compartment.** US Air National Guard/SSgt Elizabeth Rissmiller

EC-130Js receive TV and radio programmes for broadcast via electronic uplink transmission to the aircraft using its wideband satellite communications.

A new direction of future upgrade programmes was revealed in June 2020, when the Air Force requested proposals to evaluate the electronics installed on the EC-130J (and other versions of the C-130J) to identify potential upgrades and vulnerabilities to electronic attack and cyber threats. Concern for such a threat increased after an AFSOC AC-130 gunship was subjected to such attacks over Syria.

Multi-Mission Systems, Niche Capability

An internal digital broadcast system dubbed the Multi-Mission Platform-Heavy (MMP-H) is the EC-130J's main new system housed on a roll-on/roll-off palette which enables a Commando Solo II to operate in multi-mission configuration.

It was integrated and flight tested on an EC-130J between 2018 and 2019 by SOCOM's PEO for command, control, communications, and computers; MMP-H achieved initial operational capability in FY2019. MMP-H provides an upgraded broadcast capability compared to the EC-130J's original equipment comprising 1970s technology that cannot be replaced by digital (or cable) broadcasts, which was cross decked from the EC-130E Commando Solo I.

EC-130J underwing pods are integrated with its on board systems and transmit through the characteristic 'X' antennas on the fin. In the future, the original pods will be replaced by new pods dubbed MMP-E or Multi-Mission Pod – External. This is an enhanced version of Raytheon's Communications Electronic Attack Surveillance and Reconnaissance (CEASAR) pod, currently used on Beechcraft RC-12 aircraft.

MMP-E pods will provide expanded EW and EA capabilities, transmitting electronic pulses that can disable or destroy threat equipment or insert 'worms' or software that can switch them off, a capability currently operational on Compass Copes and, almost certainly, other platforms.

Pennsylvania Air National Guard's EC-130Js and the operators are a niche capability, one which might be considered as a target for budget cutters in the years to come. Yet, the seven EC-130Js enable the United States to not only block, but take control of communication networks, networks that future opponents may rely on to broadcast and communicate to their armed forces and population.

It may be significant that China is flying a counterpart, the Shaaxi X-9XZ, an upgraded version of the Shaanxi Y-8XZ with PsyOps and EA capabilities. Reportedly, the Y-9XZ has the ability to hack into communication networks and web servers, interrupt or redirect internet traffic or spread false information.

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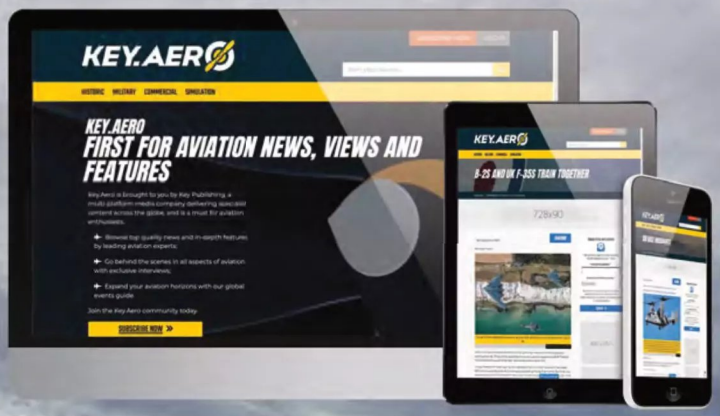

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TANKER AND AIRLIFT CONTROL

The 618th Air Operations Center is a specialised unit responsible for planning, scheduling, and tracking airlift and tanker missions around the world. Mark Ayton looks at the setup.

ST CLAIR COUNTY in southern Illinois is a mix of suburban communities and farming country. Its main crops are corn and soybeans. Economically, the county benefits from the greater metropolitan area surrounding the city of St Louis, Missouri on the west bank of the Mississippi river. It also benefits from Scott Air Force Base which spends nearly $14 billion each year in the local economy. Though Scott Air Force Base is home to three wings operating C-21, C-40 and KC-135R aircraft, its main tenants are US Transportation Command (USTRANSCOM), the Air Force's Air Mobility Command (AMC), and the Army's Military Surface Deployment and Distribution Command.

Unsurprisingly, AMC's operational component, the 18th Air Force (18th AF) is also headquartered at the base along with its 618th Air Operations Center, the command and control node for all USTRANSCOM missions around the world. Renamed the 618th AOC on August 30, 2010, the unit was originally known as the Tanker Airlift Control Center.

Running the Show

The 618th AOC runs America's National Air Mobility System, which involves planning, tasking, and directing a fleet of nearly 1,100 mobility aircraft in support of combat delivery and strategic airlift, air refuelling, and aeromedical evacuation operations, and proving air mobility support around the world. Each role is undertaken to support strategic, operational, and tactical objectives.

- Airlift is the movement of personnel and materiel with common-user airlift aircraft between or within theatres, and delivery to the intended destination by either the airland or airdrop method. Airland is the primary delivery method. The aircraft lands and its passengers disembark and/or its cargo is unloaded. Airdrop involves dropping pallets by chute.

A delivery method is selected based on user requirements, type of environment, availability, adequacy, security of airfields, landing zones, drop zones near the objective area, threats to the objective area, and aircraft/aircrew capability.

- Air refuelling is the in-flight transfer of fuel from a tanker aircraft to a receiver or receivers.

- Aeromedical evacuation is the movement of regulated patients between medical facilities by organic and/or contracted aircraft with medical aircrew trained explicitly for the mission.

- Air mobility support is the provision of responsive command and control and ground support to air mobility forces worldwide. A capability provided by a limited number of permanent en-route support locations, and deployable forces capable of augmenting the permanent en-route locations or establishing new en-route locations.

Planners working in the 618th AOC have to consider many aspects when arranging a mission. Their work includes the assessments, legal considerations, and the creation of

- an airspace control plan including preferred altitudes and routing, secure air corridors or operating areas.
- a marshalling plan, the preparations required to plan, document, and load equipment and personnel aboard the aircraft.
- an intelligence plan that addresses the commander's needs and is fully synchronized with operations, with analysis of pertinent information concerning all phases of theatre and international flight operations, at home station, APOEs, en route locations, APODs, and forward airfields pertaining to potential threats.
- a communication plan containing en route communications procedures and automated information systems to support movement reporting.
- assessments prior to and during air mobility operations of the destination airfield's capabilities and limitations, the airland facilities available, and to ensure the user's requirement is met.
- involve a legal advisor to ensure legal compliance in all stages of multinational operations planning and execution.

Methodology

The 618th is the largest air operations centre in the Department of Defense with 700 active duty, Air National Guard, Reserve, and civilian personnel assigned. They provide 24/7 command and control for worldwide mobility missions, 365 days a year, totalling roughly 500 missions every day.

Specifically, the 618th AOC receives validated common-user requests; tasks the appropriate unit; plans the mission; and provides continuous communications connectivity between inter-theatre forces, the common-user, and supporting GAMSS (global air mobility support system) forces.

Without AMC and the AOC's critical capabilities, combatant commanders would be unable to get the right people and equipment to the right place at the right time. Airmen assigned to the AOC provide continuous support to ten combatant commanders with capabilities

A planner-operator at one of the many work stations in the 618th Air and Space Operations Center (Tanker Airlift Control Center) at Scott Air Force Base, Illinois. Planner-operators assigned to the 618th plan, schedule and track tanker, airlift, and aeromedical evacuation aircraft worldwide to accomplish Air Mobility Command's global reach mission. US Air Force/Captain Justin Brockhoff

AIR MOBILITY MISSION CATEGORIES

- Aeromedical evacuation (AE) missions support the movement of patients with qualified aeromedical aircrew members (including civilian specialists with approval), may require special air traffic control considerations to comply with patient-driven altitude and pressurization restrictions, and utilise medical equipment approved for use on aircraft systems.

- Channel airlift missions provide common-user airlift service on a scheduled basis between two or more predesignated points. Channel airlift missions support passenger and cargo movement over established worldwide routes that are served by scheduled DoD aircraft under the control of AMC or a Geographic Combatant Commander's (GCC's) air operations centre/ air mobility division (AOC/AMD).

USTRANSCOM also conducts channel missions via contracted and scheduled commercial aircraft.

The majority of airlift sustainment moves on either distribution or contingency channel missions. Distribution channel missions are volume–driven, in which airlift is regularly scheduled against the volume of cargo moving through an aerial port of embarkation (APOE).

Contingency channel missions support specific operations and fly on an as-needed schedule based on cargo and passenger movement requirements from/to the predesignated points of the channel.

Distribution and contingency channels are structured such that there can be flexibility in adding airlift to accommodate surges in volume of cargo.

In many cases, channel missions operate as part of an integrated or linked set of movements from point of origin to point of need to consistently deliver requested logistics support when and where the customer requires.

- Special assignment airlift missions (SAAMs) are bought by a user to satisfy one or more validated requirements. SAAMs support DoD users, and other government agencies such as the US Secret Service, Federal Bureau of Investigation, and Drug Enforcement Administration.

- A Coronet mission is a movement of air assets, usually fighter aircraft, in support of contingencies, rotations, and exercises or aircraft movements for logistics purposes. The tanker aircraft assigned to a Coronet mission provides fuel to avoid intermediate stops and provides weather avoidance, oceanic navigation, communication, and command and control of the mission.

- Contingency missions operate in direct support of an operation order (OPORD).

- Chairman of the Joint Chiefs of Staff (CJCS) exercise missions operate in support of CJCS-directed or sponsored exercises.

- Air refuelling (AR) missions provide in-flight refuelling to users; for example, foreign military sales, aircraft transfers, and unit moves.

- Training missions are flown for crew currency and proficiency for airlift, AR, and AE. Joint airborne and air transportability training (JA/ATT) is one specific type in a joint effort between air mobility units and other DoD agencies to provide training for both. These missions include airdrop, air assault, aircraft load training, and AR.

- Intra-theatre common-user airlift missions provide routine, and time sensitive mission-critical, support to the GCC and are flown by theatre-assigned airlift aircraft to support common-user theatre movement requirements.

that enables the team to deliver rapid global mobility whenever and wherever its needed.

After the AOC receives validated mission requirements from USTRANSCOM, the details are analysed and then tasked to individual units. Specific information regarding special aircraft, equipment, or personnel are all passed to the individual units in order to best fulfil the mission requirements.

Tactical control of AMC-assigned and gained forces executing validated TRANSCOM missions and AMC service missions is delegated to the AOC by AMC's commander. Tactical control authority includes tasking the necessary aircraft, aircrew, and implied GAMSS requirements.

Routine missions (otherwise known as channel missions) are submitted to the AOC as validated mission requirements through TRANSCOM. Depending on the nature of a mission, the requirements are analysed and passed to the appropriate directorates who task available aircraft, populate a movement plan, manifest a route and planning checklist, before overseeing the flight movement real-time during mission execution.

Transformation

In May 2020, the AOC implemented a transformation, one that was critical to better support Air Mobility Command's own transformation to a warfighting major command. In turn, this is designed to help the mobility community better support Air Force efforts with the Department of Defense's concept to connect sensors from all of the military services — Air Force, Army, Marine Corps, Navy, and Space Force — into a single network. That concept is called Joint All Domain Command and Control (JADC2).

Traditionally, each of the military services developed its own tactical network that was incompatible with those of other services (i.e., Army networks were unable to interface with Navy or Air Force networks). DoD officials have argued that potential future conflicts may require decisions to be made within hours, minutes, or potentially seconds compared with the current multiday process required to analyse the operating environment and issue commands.

AMC and the Air Force are employing new concepts and technology to network friendly forces, accelerate operations, and overwhelm adversaries with simultaneous challenges from every domain.

The AOC's transformation is the largest such effort in the organisation's nearly 30-year history and replaced a structure that had remained relatively static since the mid-1990s.

The new organisational structure consists of eight directorates, 24 divisions, 11 branches and an Air Communications Squadron replacing the old ten directorates, 29 divisions and six branches. Its goal was to better integrate people, systems, and processes to provide global command and control more effectively in future multi-domain, contested environments. Historically, funding streams determined where functional directorates were positioned, but AOC's realignment streamlined teams with similar mission sets under newly created directorates. By prioritizing mission function over funding streams, the new directorates can oversee projects from cradle to grave, allowing AOC personnel to increase warfighting effectiveness and more rapidly respond to mission requirements.

One of the primary objectives of the 618th's reorganization was to increase its warfighting effectiveness and more rapidly respond to mission requirements.

Ramp operations personnel off-load a Humvee at Dover Air Force Base, Delaware. US Air Force/Roland Balik

This is supposed to be achieved by building a command structure that prioritises team interoperability. According to an AOC spokesperson: "We can now streamline mission planning and execution, conduct operations more efficiently, and allow directors to oversee missions from cradle-to-grave. The transformation will greatly enhance the 618 AOC's ability to provide resilient command and control of AMC's four core competencies – airlift, air refuelling, aeromedical evacuation, and global air mobility support."

Resilient command and control refers to the AOC's ability to conduct mission planning and movement oversight of Air Mobility aircraft in spite of external factors that may erode its ability to do so. The spokesperson said the AOC proudly conducts operations 24 hours a day, 7 days a week, 365 days a year and remains an adaptable and resilient force when supporting US objectives.

As the Air Force works toward the eventual JADC2, the author was curious to know how the transformations to AMC and the 618th will improve the posture of mobility air forces and enhance the AOC's ability to sustain America's joint force across the entire spectrum of operations.

According to the AOC spokesperson: "Transformation of the AOC accomplished three key objectives: integration of people, systems and processes. By integrating people our mission becomes more agile, modular, and scalable, resulting in more centralised mission command and a more flexible organisational structure. Integration of systems lessens our manpower burden and increases our decision speeds, making us a more resilient and distributable force. Lastly, through the integration of processes our team is more fluid when pivoting between congested and contested environments."

New System, New Facility

In March 2018, the Air Force fielded modules of a common mission planning software system called MPS Increment 5 for unit-level and centralized applications, the latter for the 618th AOC.

The system migrates legacy Air Force airlift, tanker, airdrop, and combat search and rescue mission planning systems to the JMPS or Joint Mission Planning System. JMPS software is compatible with standard Air Force computers and function in aircraft-specific mission planning environments.

One of three efforts in the MPS Increment 5 is the Mobility Air Forces Automated Flight Planning Service or MAFPS, a replacement system for the Advanced Computer Flight Plan software used by the 618th AOC. MAFPS software enables the AOC's global mission planning and route optimisation requirements for strategic airlift, aerial refuelling, and tactical airlift missions.

The MAFPS is designed to automate global mobility planning processes by integrating aircraft performance data, weather, global airspace restrictions and aeronautical charts, and geopolitical boundaries into a single planning tool. It also optimises flight paths based on time and fuel requirements.

The AOC is currently operating out of a temporary facility as renovations to its old building are being planned. Renovations are expected to take five-and-a-half years and involve a complete demolition and reconstruction of the old facility. Once completed, the new Joint Operation Mission Planning Center will include the infrastructure and capabilities needed to stay competitive well into the future.

618TH AOC DIRECTORATES

Mobility Management
Allocates units to support strategic airlift, theatre airlift, and air refuelling requirements.

Airlift Directorate
Develops detailed execution plans for airlift.

Air Refueling Directorate
Provides air refuelling support for missions.

GAMSS-AE Directorate
Provides command and control authority for aeromedical evacuation, contingency response, aerial port coordination, and en-route maintenance support.

Intelligence Reconnaissance
Provides full-spectrum, threat awareness to mobility aircrews.

Mobility Operations
Executes command and control for global employment of air mobility forces.

Strategy Directorate
Enables situational awareness and understanding to inform the planning, tasking, execution, and assessment of the delivery of air mobility requirements.

Weather
Analyses weather impacts to the global mobility enterprise and ensures seamless integration of weather data into the command and control systems.

Air Communications Squadron
Sustains, integrates, and protects the cyber infrastructure while managing overall cyber operations and cybersecurity programs of the 618th AOC.

AIR POWER REVIEW

Tom Kaminski takes an in-depth look at the units, bases and aircraft that constitute US Air Force air power in 2021.

THE US AIR Force is in a continuous period of change that allows the service to adapt to meet new and revised threats worldwide. The moves affect its structure, the types and number of platforms it operates, and basing for its assets.

These moves all support the National Defense Strategy. The latest version of the strategy was released in 2018 and is aimed at "restoring America's competitive military advantage" over Russia and China. This strategy shifts away from the post-Desert Storm model and modernises key capabilities and innovates using new technologies and operational concepts to maintain effective deterrence. It provides a more lethal, resilient, and rapidly innovating Joint Force.

The new strategy emphasizes the importance of modernisation of the nuclear triad, command-and-control assets and intelligence, surveillance, and reconnaissance capabilities.

Reorganisation

On August 20, 2020, Air Combat Command (ACC) completed a reorganisation that was a major step in the service's implementation of a new dynamic force generation in support of the National Defense Strategy. As part of the move, the US Air Force's largest Major Command (MAJCOM), activated the Fifteenth Air Force (15AF) at Shaw Air Force Base, South Carolina, which assumed control of the command's conventional combat forces. The wings and direct reporting units had previously reported to the Ninth Air Force (9AF) at Shaw and the Twelfth Air Force (12AF) at Davis-Monthan Air Force Base, Arizona. Those forces comprise the US Air Force's fighter, battle management/command and control, combat rescue and remotely piloted aircraft flying units, as well as a large number of support organisations.

In addition to organising, training, and equipping these forces, 15AF can deploy a Joint Task Force headquarters capable of providing command and control (C2) of integrated combat forces.

The 15AF was last active as the Fifteenth Expeditionary Mobility Task Force (15 EMTF) until inactivated at Travis Air Force Base, California, on March 20, 2012. It had previously been responsible for the US Air Force's tanker fleet as part of Air Mobility Command from June 1, 1992 until it was redesignated on October 1, 2003.

The move also saw the inactivation of the Ninth Air Force at Shaw and the redesignation of Air Force Central Command as Ninth Air Force/Air Forces Central Command (9AF/AFCENT).

The move permits the 9AF/AFCENT and Twelfth Air Force/Air Forces Southern Command (12AF/AFSOUTH) to focus on their respective component roles in support of US Central Command (USCENTCOM) and US Southern Command (USSOUTHCOM). These moves followed the activation of the Sixteenth Air Force/Air Forces Cyber (16AF/AFCYBER) at Joint Base San Antonio-Lackland, Texas, on October 11, 2019. Considered the Air Force's Information Warfare Numbered Air Force (NAF), the 16AF integrated multisource intelligence, surveillance and reconnaissance, cyber warfare, electronic warfare, and information operations capabilities.

New Plans, New Planes

During 2020, the Pentagon confirmed it had cancelled plans to relocate AFSOC's 352nd Special Operations Wing and US Air Force's 100th Air Refueling Wing from RAF Mildenhall, England, to Spangdahlem Air Base, Germany. The planned moves were first revealed in the Pentagon's 2015 European Infrastructure Consolidation Plan but delayed several times from 2017 to 2022 and then 2027. The change came following the decision to relocate the 52nd Fighter Wing's F-16Cs from Spangdahlem to Aviano Air Base, Italy. The decisions were part of a larger plan to withdraw 11,900 US personnel from Germany.

The US Air Force continues to field new aircraft while it continues to struggle

A crew chief with the 389th Fighter Squadron receives an F-15E Strike Eagle from Mountain Home Air Force Base, Idaho, after arriving at Tyndall Air Force Base, Florida, on October 24, 2020. The 389th Fighter Squadron was deployed to Tyndall for Exercise Agile Flag 21-1. US Air Force/Senior Airman Andrew Kobialka

with an aging fleet. F-35A fleet expansion continues to make progress and Eielson Air Force Base, Alaska became the first location outside the Continental US (OCONUS) to field the Lightning II when the first F-35As were delivered to the 354th Fighter Wing on April 21, 2020. Deliveries to the Vermont Air National Guard were completed on October 14, 2020 when the 158th Fighter Wing accepted the last of its 20 Lightning IIs.

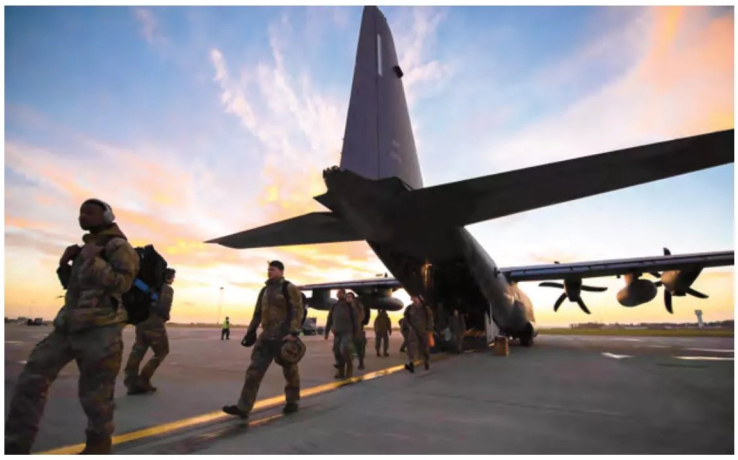
The service is also moving forward with plans to acquire up to 200 new F-15EXs. Acquisition of the updated fourth-generation fighters will permit the US Air Force to recapitalize the Air National Guard's F-15Cs that primarily support the homeland air defence mission.

Fielding of new KC-46A Pegasus tankers continues despite the need to resolve technical issues discovered during testing. Although the tankers have not been cleared for operational tasking, they have begun supporting operational training and deployments.

The service has also begun looking at options for contracted aerial refuelling support to relieve the strain on its tanker fleet and permit it to concentrate on operational missions. The contracted tankers would be limited to providing support for training and exercises.

While ACC expands the use of contracted air support for dissimilar aircraft training, the Air Force Reserve will be taking over responsibility for day-to day operations of the US Air Force's aggressor fleet at Nellis Air Force Base, Nevada. The F-16Cs are currently the responsibility of the 57th Wing's 64th Aggressor Squadron, which will transition to an active associate status, when the Vipers are reassigned to the reserve's 926th Operations Group. The group's 706th Fighter Squadron currently supports the active-duty mission with personnel under a classic association.

The US Air Force is increasing its use of innovative virtual training methods in order to reduce the time required to train and produce pilots. Its Pilot Training Next (PTN) programme is part of a greater effort that will completely redesign its flight training programme. In addition to new training aircraft and ground-based training devices, the PTN will utilize virtual reality, artificial intelligence, and data analytics, that can be used to tailor the training environment for individual students. Additionally, Air Education Training Command is revamping its Specialized Undergraduate Pilot Training (SUPT) programme in advance of the delivery of its new T-7A advanced jet trainers.



Maintainers assigned to the 352nd Special Operations Wing unload cargo in support of a bilateral exercise at Såtenäs Air Wing, Sweden, on November 9, 2020. US Army/ Sgt Patrik Orcutt

A new ACC concept of operations dubbed 'Rebuilding the Forge' or 'Reforge' could lead to the most radical transformation of fighter pilot training since the 1950s. Reforge could potentially reduce the time required for a student to transition from starting SUPT to becoming a combat-ready fighter pilot from the current 40 months to as little as 18. It leverages new virtual reality and simulation technology, as well as in-flight simulation capabilities integrated in the T-7A Red Hawk. If successful it could result in the acquisition of an additional 100 T-7A aircraft from Boeing.

The service continues to look at new concepts including the so-called 'Arsenal Plane'. During the US Air Force's recent Advanced Battle Management System evaluations, Air Mobility Command conducted a proof-of-concept test that saw Joint Direct Attack Munitions dropped from C-17As. The test demonstrated how mobility forces could be used in non-traditional ways.

Agile Combat and Dynamic Force Employment

In April 2020, Air Force Global Strike Command moved away from maintaining a permanent bomber presence in the Pacific region under its Continuous Bomber Presence mission. Instead, the command adopted a Dynamic Force Employment (DFE) model that deploys Bomber Task Forces (BTFs) from the continental US on long-distance missions or short duration deployments to Andersen Air Force Base, Guam. The new employment model duplicates that already used by the command for its BTF missions to Europe, more specifically RAF Fairford, England. The new employment model has already contributed to improve bomber force readiness, while permitting the force to respond to demands.

Together with the Agile Combat Employment concept of operations for fighter and support aircraft, the DFE is intended to deny America's adversaries knowing where US forces are located, what their activities are, their operational range and point of origin.

Using the ACE concept of operations, the service would launch, recover, and maintain its fighters from unorthodox locations that include partner nations' military airfields or civilian airports rather than their home stations.

Development of new weapons is another important task that is underway. The service is supporting the development of new hypersonic weapons and is seeking a range of capabilities that include weapons in different size categories. These include a larger weapon with greater range employed by bombers, and a smaller, shorter-range weapon for fighter aircraft.

In the near term, the Air Force is moving forward with the AGM-183 Air-launched Rapid Response Weapon that could provide an interim capability while more advanced weapons are developed.

Lockheed Martin is developing the AGM-183 long-range boost glide weapon, which will be propelled to a maximum speed of over 15,300mph (Mach 20) by a rocket motor before gliding towards its target. The US Air Force hopes to achieve an operational capability with the ARRW as early as September 2022.

While continuing to support worldwide operations in the 'global war on terror', the Air Force continues to move to new employment models and modernisation. The service remains committed to supporting Operation Freedom's Sentinel and Combined Joint Task Force

– Operation Inherent Resolve (CJT-OIR) in Afghanistan, Iraq and Syria; Combined Joint Task Force-Horn of Africa; Operation Atlantic Resolve in Europe as well as overseas contingency operations that are carried out from locations around the globe. Additionally, the service remains committed to conducting worldwide humanitarian missions on an as-required basis.

Statistics provided by the FY2021 Air Force posture statement (released in February 2020) show the service conducted more than 75,000 strike sorties during 2019. Those missions delivered over 11,000 weapons against Islamic State targets in Iraq and Syria, and the Taliban and other extremist networks in Afghanistan.

Mobility aircraft flew over 27,000 airlift and refuelling sorties that delivered over 113,000 tons of equipment and supplies and offloaded 590 million pounds of fuel.

In addition to combat operations, the service continues to conduct rotational deployments in support of NATO under the European Deterrence Initiative (EDI). First announced in 2014 as the European Reassurance Initiative, the EDI enables the US to enhance its deterrence posture, increase the readiness and responsiveness of its forces in Europe, support the defence and security of NATO allies, while bolstering the security and capacity of its allies and partners.

Besides its worldwide commitments, the US Air Force has many operational missions that take place with the US and its territories. Among the most important is the 24/7 alert mission carried out at 16 aerospace control alert locations in support of US Northern Command (NORTHCOM). Homeland operations are also conducted in response to natural disasters under the auspices of NORTHCOM and the Federal Emergency Management Agency.

Budget Request

Released in February 2020, the Department of Defense's budget request for FY2021 totalled $740.5 billion and included $66.0 billion for OCO. The Air Force's share of the request totalled $169.0 billion to fund a force of 512,100 personnel. The FY2021 budget was aligned directly with the 2018 National Defense Strategy.

The request includes operational funding for 5,487 aircraft and 1,238,206 flying hours. It supports a total aircraft inventory (TAI) of 4,155 aircraft within the active component, 1,010 in the Air National Guard and 322 in Air Force Reserve Command. Additionally, $25.4 billion in procurement funding provides $17.9 billion for 106 new manned and unmanned aircraft; comprising 12 F-15EX and 48 F-35A fighters, 15 KC-46A tankers, four MC-130J special operations aircraft, one EC-37B electronic warfare airframe, eight MH-139A helicopters and 19 HH-60W combat rescue helicopters including three funded under the OCO request.

Organisation

The US Air Force was formally established as an independent branch of the Armed Forces on September 18, 1947 when the Army Air Forces were separated from the US Army.

The Department of the Air Force is headquartered at the Pentagon in Arlington, Virginia, and led by a four-star general. The Chief of Staff of the Air Force is responsible for organising, training, and equipping active-duty, Air National Guard, Air Force Reserve Command airmen and civilian personnel.

Organized into ten MAJCOMs, which include the Air National Guard and Air Force Reserve, combined they are responsible for more than 5,500 combat, training, airlift, tanker, intelligence, and support aircraft. Whereas the Air Force's active component is responsible for the bulk of the total force, the Air National Guard adds 21% and Air Force Reserve Command makes up the remaining 14%.

Each MAJCOM is led by a four-star general or a three-star lieutenant general.

A B-1B Lancer from Ellsworth Air Force Base, South Dakota and F-16 Fighting Falcons from Misawa Air Base, Japan, conducted joint training with Japan Air Self-Defense Force F-2s off the coast of Northern Japan, April 22, 2020 to demonstrate the dynamic force employment concept. US Air Force/TSgt Timothy Moore

The organisations are each tasked to support and conduct one or more of the service's five interdependent and integrated core missions:

- Air and Space Superiority
- Command and Control
- Intelligence, Surveillance and Reconnaissance (ISR)
- Global Strike
- Rapid Global Mobility'

Air Combat Command (ACC)

Established on June 1, 1992, through a consolidation of assets of Strategic Air Command and Tactical Air Command, ACC is headquartered at Joint Base Langley-Eustis, Virginia. It is the primary provider of combat air forces to combatant commands including US Africa Command (AFRICOM), US Central Command (CENTCOM), US Indo-Pacific Command (INDOPACOM), US European Command (EUCOM), US Northern Command (NORTHCOM) and US Southern Command (SOUTHCOM).

Six Numbered Air Forces (NAFs) include one aligned under the Air Force Reserve Command and another staffed by the Air National Guard.

ACC's Direct Reporting Units include the US Air Force Warfare Center at Nellis Air Force Base. ACC is responsible for more than 1,130 manned and remotely piloted aircraft, and nearly 78,250 active-duty personnel and 50,000 Air National Guard and Air Force Reserve Command airmen.

Air Education and Training Command (AETC)

Headquartered at Joint Base San Antonio-Randolph, Texas, AETC's two NAFs provide basic military, initial and advanced technical and flight training. The command is responsible for approximately 1,450 aircraft, and more than 29,000 active-duty and 6,000 Air National Guard and Air Force Reserve Command personnel. It is the Air Force's second oldest MAJCOM and traces its history to the activation of the Army Air Corps Flying Training Command in January 1942. AETC assumed its current identity in July 1993, when the Air Training Command and the Air University were merged.

Air Force Global Strike Command (AFGSC)

Activated on August 7, 2009, AFGSC is responsible for the nation's intercontinental ballistic missile wings and strategic bombers. It serves as the US Air Force component of US

F-35A 18-5345/AK launches from Eielson Air Force Base, Alaska, on the 356th Fighter Squadron's first launch on April 24, 2020. Based at Eielson, the 356th Fighter Squadron is Indo-Pacific Command's first F-35A squadron. US Air Force/MSgt Karen Tomasik

Strategic Command (STRATCOM) and is headquartered at Barksdale Air Force Base, Louisiana. AFGSC's fleet includes over 175 aircraft comprising the B-1B Lancer, B-2 Spirit and B-52H Stratofortress strategic bombers, E-4B command and control aircraft and T-38A and UH-1N support aircraft.

Air Force Materiel Command (AFMC)
AFMC is responsible for the complete life cycle management for air force weapon systems. Its organisations conduct research, development, test, and evaluation, provide acquisition management services and logistics support for all weapon systems.

Established on July 1, 1992, the command is responsible for the Air Force Test Center at Edwards Air Force Base, California, the Air Force Life Cycle Management Center at Wright-Patterson Air Force Base, Ohio, the Air Force Sustainment Center at Tinker Air Force Base, Oklahoma, the Air Force Nuclear Weapons Center at Kirtland Air Force Base, New Mexico and the National Museum of the US Air Force at Wright-Patterson Air Force Base, Ohio. Over 16,700 active-duty personnel are assigned. Although its fleet size fluctuates, at the end of FY2020 AFMC had more than 120 fixed and rotary-wing aircraft on its roster.

Air Force Reserve Command (AFRC)
Headquartered at Robins Air Force Base, Georgia, AFRC's three NAFs are responsible for more than 30 flying wings. Each NAF is aligned with a specific mission set comprising strategic reach, power and vigilance and tactical reach/combat support. The command's associate wings and squadrons share the responsibility for the operation and maintenance of the aircraft assigned to co-located active component units. More than 65,500 personnel are assigned to the command, along with approximately 320 aircraft.

Air Force Special Operations Command (AFSOC)
Established on May 22, 1990, AFSOC serves as the US Air Force component of US Special Operations Command (SOCOM). Headquartered at Hurlburt Field, Florida, the command is responsible for five active-duty special operations wings and a single active-duty special operations group. The organizations are located at stateside bases and in Europe and Japan. Its reserve components comprise an Air Force Reserve Command and two Air National Guard and special operations wings. Around 15,350 personnel and more than 190 manned and remotely piloted aircraft are currently assigned to AFSOC.

Air Mobility Command (AMC)
AMC is the air component of US Transportation Command (USTRANSCOM), it operates around 450 airlift and tanker aircraft with over 28,200 personnel assigned. Its assets and personnel are assigned to active-duty, Air National Guard and Air Force Reserve Command wings, groups, and squadrons. AMC is responsible for a single NAF as well as the US Air Force Expeditionary Center at Joint Base McGuire-Dix-Lakehurst, New Jersey.

Headquartered at Scott Air Force Base, Illinois, the command was established when assets from the Strategic Air Command and Military Airlift Command were consolidated on June 1, 1992. Its history is however traced to the establishment of the Air Corps Ferry Command in May 1941, making it the US Air Force's oldest MAJCOM. AMC is the gaining command for two Air Force Reserve Command NAFs and their assigned wings and a large number of Air National Guard wings.

Pacific Air Forces (PACAF)
As the air component of US Indo-Pacific Command (USINDOPACOM), PACAF is responsible for three NAFs, around 31,200 personnel and approximately 320 aircraft that are based in Alaska, Hawaii, Guam, Japan, and South Korea. Headquartered at Joint Base Pearl Harbor-Hickam, Hawaii, the command is also responsible for gained Air National Guard and Air Force Reserve Command units in Alaska, Hawaii, and Guam.

US Air Forces Europe — Air Forces Africa (USAFE-AFRICA)
A single NAF, eight wings, 23,070 personnel and nearly 200 aircraft are assigned to USAFE-AFRICA, which serves as the air component for both US European Command (EUCOM) and US Africa Command (AFRICOM). The command also maintains administrative control over the US Air Force personnel assigned to NATO's Heavy Airlift Wing, at Papa Air Base, Hungary.

Headquartered at Ramstein Air Base, Germany, USAFE-AFRICA is responsible for directing air operations in a theatre that spans three continents, covers more than 19 million square miles, and contains over 100 independent states.

Air National Guard (ANG)
The Air National Guard is the US Air Force's second largest component and provides nearly half of the Air Force's tactical airlift support, combat communications functions, aeromedical evacuations, and aerial refuelling. It is administered by the joint bureau of the departments of the Army and Air Force, known as the National Guard Bureau (NGB). The Air National Guard is headquartered at the Pentagon in Arlington, Virginia, and is responsible for units assigned to all 50 states, the District of Columbia and the US territories of Puerto Rico, the Virgin Islands and Guam. Its units are tasked with both state and federal missions and the Air National Guard's flying units are responsible for over 1,030 fixed-wing, rotary-wing, and remotely piloted aircraft and more than 105,600 personnel.

AIRCRAFT AND SQUADRONS OF THE US AIR FORCE

A-10C Thunderbolt II

Between January 2005 and July 2011, the US Air Force upgraded around 350 A-10As to A-10C configuration under the Precision Engagement (PE) programme. Under the PE programme, the aircraft was equipped with the AAQ-28 Litening or AAQ-33 Sniper targeting pods, a MIL-STD-1760 databus, and a digital stores management system, two multi-function colour displays and a new armament/head-up display control panel. The upgraded model achieved initial operational capability with the Maryland Air National Guard's 104th Fighter Squadron in August 2007.

Upgrades also added the Scorpion helmet-mounted cueing system (HMCS), which is now being replaced by the Thales Visionix helmet. Another upgrade will integrate the GPS-guided 250lb GBU-39 Small Diameter Bomb (SDB) and BRU-61/A bomb rack, plus Link 16 data link. Conducted as part of the Common Fleet Initiative , initiated in August 2018, integration of the BRU-61 will permit the A-10C to carry four SDBs on each pylon. The enhancements will also provide the A-10C with a High Resolution Display System (HRDS). In addition to functioning as a Primary Flight Display, the HRDS will display high-resolution video from Advanced Targeting Pods. The digital interface will replace the Warthog's legacy analogue flight instruments and provide higher resolution video signals that improve the pilot's ability to find, fix, track, target and engage ground targets and threats while reducing workload.

Plans to provide 242 A-10Cs with new Boeing-produced wings were stopped short after 173 aircraft were upgraded. The new Enhanced Wing Assemblies have a service life of 10,000 flight hours. The effort was restarted under the A-10 Thunderbolt Advanced-Wing Continuation Kitting program in 2018 and in August 2019, Boeing received a $240 million contract for 27 wing sets. A further 22 sets were funded in FY2020 and 24 were requested in FY2021. The project will procure 112 wing sets for delivery by 2028.

The US Air Force plans to spend around $571.4 million on fleet modernization over the FYDP between FY2021 and 2025.

The operational A-10C inventory fleet currently includes 281 jets that are assigned to 18 active-duty, Air National Guard and Air Force Reserve Command units. The fleet comprises 116 aircraft with Air Combat Command, 24 in Pacific Air Forces, 85 within the Air National Guard and 55 with the Air Force Reserve Command. A single A-10C is assigned to Air Force Materiel Command.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
AATC	Davis-Monthan Air Force Base, Arizona	A-10C	57th Wing/ USAFWS	ACC	DP
358th FS (see Note 1)	Whiteman Air Force Base, Missouri	A-10C	20th FW/495th FG	ACC	KC
25th FS	Osan Air Base, Republic of Korea	A-10C	51st FW/ OG	PACAF	OS
40th FLTS	Eglin Air Force Base, Florida	A-10C	96th TW/ OG	AFMC	ET
66th WPS	Nellis Air Force Base, Nevada	A-10C	57th Wing/ USAFWS	ACC	WA
75th FS	Moody Air Force Base, Georgia	A-10C	23rd Wing/23rd FG	ACC	FT
74th FS	Moody Air Force Base, Georgia	A-10C	23rd Wing/23rd FG	ACC	FT
354th FS	Davis-Monthan Air Force Base, Arizona	A-10C	355th Wing/FG	ACC	DM
357th FS (FTU)	Davis-Monthan Air Force Base, Arizona	A-10C	355th Wing/FG	ACC	DM
422nd TES	Nellis Air Force Base, Nevada	A-10C	53rd Wing/53rd TEG	ACC	OT
Air National Guard units					
104th FS	Martin State Airport/Warfield Air National Guard Base, Baltimore, Maryland	A-10C	175th Wing/OG	ACC	MD
107th FS	Selfridge Air National Guard Base, Mount Clemens, Michigan	A-10C	127th Wing/OG	ACC	MI
163rd FS	Fort Wayne International Airport, Indiana	A-10C	122nd FW/ OG	ACC	IN
190th FS	Boise Airport-Gowen Field, Idaho	A-10C	124th FW/ OG	ACC	ID
Air Force Reserve Command units					
47th FS (FTU)	Davis-Monthan Air Force Base, Arizona	A-10C	944th FW/924th FG	ACC	DP
76th FS (see Note 2)	Moody Air Force Base, Georgia	A-10C	442nd FW/476th FG	ACC	FT
303rd FS	Whiteman Air Force Base, Missouri	A-10C	442nd FW/ OG	ACC	KC
706th FS (see Note 3)	Nellis Air Force Base, Nevada	A-10C	926th Wing/OG	ACC	WA

Notes
1 Active associate squadron utilises aircraft assigned to Air Force Reserve Command's 442nd Fighter Wing.
2 Classic associate squadron utilises aircraft assigned to 23rd Fighter Group.
3 Classic associate squadron utilises aircraft assigned to 53rd Wing.

An A-10C Thunderbolt II performs a low-angle strafe at Barry Goldwater Range, Arizona. US Air Force/Senior Airman Chris Drzazgowski

B-1B Lancer

The Air Force currently operates 60 B-1Bs. The long-range, multi-mission bomber now carries the largest payload of guided and unguided conventional weapons in the US Air Force inventory. It was the first aircraft to field the Lockheed Martin AGM-158B Joint Air-to-Surface Standoff Missile-Extended Range (JASSM-ER) and the AGM-158C Long-Range Anti-Ship Missile (LRASM), which achieved early operational capability in December 2018. The B-1B can carry up to 24 LRASMs.

The Conventional Mission Upgrade Program enabled the B-1B to deliver precision-guided weapons. Its versatility was further increased when it gained the ability to carry a Sniper targeting pod.

Initiated in 2012, the $1.25 billion Integrated Battle Station (IBS) and Sustainment Block 16 project was completed in September 2020. The programme was the largest modification developed for the Lancer and improved situational awareness, battlefield communications, reduced crew workload, and added time-critical targeting and precision engagement capabilities to the bomber. It was developed as three separate modifications comprising the Fully Integrated Data Link, Vertical Situational Display Unit (VSDU) and Central Integrated Test System. The cockpit upgrade included four new displays for the pilot and co-pilot, six new displays for the weapons systems operators, and new control equipment for the flight crew.

The integration of the Fully Integrated Data Link enables full B-1B participation in joint combat and time-critical targeting operations. The VSDU replaced pilot and co-pilot primary flight displays and associated flight instruments with two 8 x 6in colour displays.

Ongoing upgrades will provide the Lancer with the Rockwell Collins Multifunctional Information Distribution System-Joint Tactical Radio System terminal, which provides improved communications and networking. The Air Force's FY2021 budget request called for the removal of 17 'structurally deficient' aircraft from service, reducing the B-1B fleet to just 45 aircraft.

B-1B Lancers on the flight line during sunset at Al Udeid Air Base, Qatar. US Air Force/TSgt Ted Nichols

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
9th BS	Dyess Air Force Base, Texas	B-1B	7th BW/OG	AFGSC	DY
28th BS (FTU)	Dyess Air Force Base, Texas	B-1B	7th BW/OG	AFGSC	DY
31st TES (see Note 1)	Edwards Air Force Base, California	B-1B	53rd Wing/53rd TEG Det. 1	ACC	ED
34th BS	Ellsworth Air Force Base, South Dakota	B-1B	28th BW/ OG	AFGSC	EL
37th BS	Ellsworth Air Force Base, South Dakota	B-1B	28th BW/ OG	AFGSC	EL
77th WPS	Dyess Air Force Base, Texas	B-1B	57th Wing/US Air Force Weapon School	ACC	WA
337th TES (see Note 2)	Dyess Air Force Base, Texas	B-1B	53rd Wing/53rd TEG	ACC	DY
419th FLTS	Edwards Air Force Base, California	B-1B	412th TW/ OG	AFMC	ED
Air Force Reserve Command unit					
345th BS (see Note 3)	Dyess Air Force Base, Texas	B-1B	307th BW/489th BG	Air Force Reserve Command	DY

Notes
1 Squadron utilises aircraft assigned to 419th FLTS
2 Squadron utilises aircraft assigned to 28th BW.
3 Classic associate squadron utilises aircraft assigned to the 7th BW.

B-2 Spirit

B-2 bombers have flown more than 3,000 combat hours that included a record-breaking 44.3-hour mission flown against targets in Afghanistan. The bomber's most recent combat missions were carried out in January 2017 against targets in Libya. The long-range B-2 has an unrefuelled range of 6,000 miles but with a single aerial refuelling, the Spirit can fly 10,000 miles.

Development of the low-observable B-2 began in November 1981, when Northrop received a $7.3-billion contract to design the Advanced Technology Bomber. Plans originally called for a fleet of 132 bombers but only 21 had been delivered when production ended.

The Spirits were initially delivered in Block 10 configuration that possessed a combat capability limited to 2,000lb Mk84 conventional bombs or gravity nuclear weapons. Progressive upgrades saw the Block 20 variant that featured the interim capability to deliver the GPS-Aided Munition. Full capability was achieved with the Block 30 configuration, which gained additional radar modes and, enhanced terrain-following capability. The Block 30's weapons capabilities included the Joint Direct Attack Munition (JDAM) and the Joint Stand-Off Weapon. The current Block 30 B-2 can carry as many as 80 500lb GBU-38 JDAMs.

A series of incremental upgrades have provided the B-2 with new communications systems, upgraded radar and additional weapons including the 30,000lb bunker busting GBU-57 Massive Ordnance Penetrator. In its nuclear penetrator role, the B-2 will carry the precision-guided B61-12 nuclear bomb when it is fielded. Flight tests with the upgraded nuclear weapon began in June 2018. Operational testing of the B61-12, which consolidates four legacy B61 variants (Mods 3, 4, 7, and 10) into a single variant, is continuing. Further weapons upgrades will incorporate the capability to simultaneously carry a rotary launcher and a smart bomb rack assembly.

The Air Force recently reduced the scope of the B-2's Defensive Management System — Modernized (DMS-M), which has suffered from major delays. The DMS-M/Displays program will provide the bomber with updated receiver-processors, antennas and display system that will improve aircrew situational awareness and aircraft survivability. The $3-billion upgrade's development was previously extended to mid-2022 and the upgraded bomber was expected to achieve initial operational compatibility in late-2024.

Under current plans the B-2s will be retired no later than 2032.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
13th BS (FTU)	Whiteman Air Force Base, Missouri	B-2	509th BW/ OG	AFGSC	WM
31st TES (see Note 1)	Edwards Air Force Base, California	B-2	53rd Wing/53rd TEG	ACC	ED
72nd TES (see Note 1)	Whiteman Air Force Base, Missouri	B-2	53rd Wing/53rd TEG	ACC	WM
325th WPS (see Note 1)	Whiteman Air Force Base, Missouri	B-2	53rd Wing/53rd TEG	ACC	DY
393rd BS	Whiteman Air Force Base, Missouri	B-2	509th BW/ OG	AFGSC	WM
419th FLTS	Edwards Air Force Base, California	B-2	412th TW/ OG	AFMC	ED
Air National Guard units					
110th BS (see Note 2)	Whiteman Air Force Base, Missouri	B-2	131st BW/ OG	AFGSC	WM

Notes
1 Squadron utilises aircraft assigned to the 412th Test Wing.
2 Classic associate squadron utilises aircraft assigned to the 509th BW.

B-21 Raider

Northrop Grumman was awarded a contract to develop the new Long-Range Strike Bomber by the Air Force in October 2015. Development commenced in February 2016. It was named the Raider in September 2016.

Like the earlier B-2, the new bomber will feature stealth capabilities, carry a large payload, and conduct conventional and nuclear deterrent missions. The B-21 Raider will be similar in configuration to the B-2, but the design will make a greater use of mature technologies.

Northrop Grumman is developing the B-21 under a cost-plus engineering and manufacturing development contract valued at an estimated $21.4 billion. The average cost for each bomber is expected to be $564 million, in 2016 US dollars and the Air Force's plans include the procurement of 100 or more aircraft. The 21 jets included in the initial five lots will be purchased under a fixed-price incentive contract.

Northrop Grumman will assemble the B-21s at Air Force Plant 42 in Palmdale, California, and flight testing will be carried out nearby at Edwards Air Force Base. Those efforts will be under the cognizance of the 420th Flight Test Squadron. When it achieves IOC, the B-21 will initially be limited to carrying conventional standoff and direct attack weapons. However, it will be certified to carry nuclear weapons within two years of the initial conventional capability.

Initial basing plans will see B-21s stationed at Dyess Air Force Base, Texas, Ellsworth Air Force Base, South Dakota and Whiteman Air Force Base, Missouri. In March 2019, the Air Force announced the selection of Ellsworth as the first operational base to receive the B-21 when fielding begins around 2025. It will also be home to the type's Formal Training Unit .

The design of the new bomber was frozen following the completion of the September 2019 critical design review. The Air Force requested $2.85 billion in FY2021 to continue B-21 development. Production of the first aircraft is currently underway at Palmdale. Roll out is expected in December 2021 with first flight in 2022.

Airmen prepare a B-52H Stratofortress for a mission at RAF Fairford, England on September 2, 2020. US Air Force/SrA Xavier Navarro

B-52H Stratofortress

The B-52H remains the Air Force's most numerous bomber with a fleet of 76 in service. Additionally, 12 examples remain in storage at Davis-Monthan Air Force Base, Arizona. Boeing delivered 744 aircraft to the Air Force in eight major versions between 1955 and October 1962, when the service accepted the last of 102 B-52Hs.

The Stratofortress is the longest-serving combat aircraft in US history and has received many upgrades that allowed it to take on new roles and be adapted for new missions. The bomber has a maximum weapons payload of over 70,000lb that permits it to deliver the most diverse range of nuclear and conventional weapons of any combat aircraft in the inventory.

The ability to deliver nuclear weapons was removed from 30 operational bombers, and 13 stored with the 309th AMARG, in order to meet the requirements of the New START nuclear weapons treaty with Russia. It limits the US to just 66 nuclear-capable bombers comprising 46 B-52Hs and 20 B-2s.

Under plans revealed by the Air Force's 2018 'Bomber Vector', the AFGSC will retain the Stratofortress until 2050 or beyond. Under that plan, 76 B-52Hs will be operated alongside 100 B-21s.

The Air Force continues to update the bomber with enhancements designed to improve its combat capabilities in the digital battlespace. Carried out during programmed depot maintenance at the Oklahoma City Air Logistics Complex at Tinker Air Force Base, Oklahoma, the Combat Network Communications Technology (CONECT) programme is installing new multi-functional colour displays , new computer architecture, multiple data links and enhanced voice communications capabilities.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
11th BS (FTU) (see Note 1)	Barksdale Air Force Base, Louisiana	B-52H	2nd BW/OG	AFGSC	BD
20th BS	Barksdale Air Force Base, Louisiana	B-52H	2nd BW/OG	AFGSC	LA
23rd BS	Minot Air Force Base, North Dakota	B-52H	5th BW/OG	AFGSC	MT
49th TES	Barksdale Air Force Base, Louisiana	B-52H	53rd Wing/53rd TEG	ACC	OT
69th BS	Minot Air Force Base, North Dakota	B-52H	5th BW/OG	AFGSC	MT
96th BS	Barksdale Air Force Base, Louisiana	B-52H	2nd BW/OG	AFGSC	LA
31st TES (see Note 2)	Edwards Air Force Base, California	B-52H	53rd Wing/53rd TEG	ACC	ED
340th WPS (see Note 2)	Barksdale Air Force Base, Louisiana	B-52H	57th Wing/ US Air Force Weapon School	ACC	LA
419th FLTS	Edwards Air Force Base, California	B-52H	412th TW/OG	AFMC	ED
Air Force Reserve Command units					
93rd BS (FTU)	Barksdale Air Force Base, Louisiana	B-52H	307th BW/OG	AFGSC	BD

Notes
1 Active associate squadron utilises aircraft assigned to Air Force Reserve Command's 93rd BS.
2 Squadron utilises aircraft assigned to the host wing.

The programme delivers the capability for B-52H crews to receive and send real-time digital intelligence, mapping and targeting information and communicate with other platforms via satellite. The CONECT's capabilities enable mission re-tasking for AGM-86C/D Conventional Air-Launched Cruise Missile and AGM-158 Joint Air-to-Surface Stand-off Missile/JASSM-Extended Range (JASSM/JASSM-ER) weapons re-targeting. Modifications to the first aircraft were completed in mid-2014 and CONECT-equipped B-52Hs began their first combat deployment in September 2016.

The bomber's Conventional Rotary Launcher (CRL) enables the carriage of smart weapons, including the AGM-158 JASSM/JASSM-ER internally. The CRL capability was fielded by aircraft from the 69th Expeditionary Bomb Squadron that deployed to Al Udeid Air Base, Qatar, in November 2017.

The Air Force plans to introduce a new external weapon pylon that will replace the Improved Common Pylon . The new pylon will quadruple the bomber's external bomb load and enable it to carry multiple weapons in the 5,000lb to 20,000lb-weight class.

The Air Force is moving ahead with plans to replace the B-52H's Pratt & Whitney TF33-PW-103 turbofans with more modern commercial-derivative powerplants. Under the Commercial Engine Replacement Program (CERP) the service will acquire around 650 new engines for the B-52H fleet.

The Air Force released a Request for Proposals (RFP) for the CERP program in May 2020 and expects to make a final selection of the new engine in January 2021. Begun in 2018, the program will greatly improve reliability and fuel consumption and range by 30% and 40% respectively. Rolls-Royce, GE Aviation and Pratt & Whitney all responded to the RFP offering the F130, CF34-10 and PW800 engines.

Boeing, which serves as the lead integrator for CERP, is defining engine and aircraft requirements as part of risk reduction efforts. The program calls for the installation of eight engines and associated electronics without redesigning or replacing existing wing structure.

Modification of two test aircraft could get underway in FY2022 with low rate initial production of the first 11 operational aircraft following in FY2026. Full-rate production for the remaining 63 aircraft will follow in six production lots beginning in FY2028. Fleet modifications will be completed in 2037.

C-5M Super Galaxy

The Air Force's fleet of 52 C-5Ms includes 36 that are assigned to two active-duty squadrons and shared by co-located Air Force Reserve Command associate units. Two additional reserve squadrons are each assigned eight Super Galaxies. The airlifter provides the Air Force with the capability to carry outsized cargo over intercontinental ranges.

Military Airlift Command received the first of 81 C-5As in June 1970. Lockheed later reopened the Galaxy production line and the first of 50 improved C-5Bs was accepted in January 1986. Deliveries concluded in March 1989.

An Avionics Modernization Program provided 27 C-5As, 50 C-5Bs and two C-5Cs with updated digital cockpits between 2002 and 2012.

Under the Reliability Enhancement and Re-engining Program (RERP), the service replaced the Galaxy's General Electric TF39 turbofans with General Electric F138-GE-100 (CF6-80C2) engines. In addition to improving fuel consumption, the F138 delivered a 22% increase in power. RERP also incorporated more than 50 improvements to the Galaxy's structure and systems that included a new auxiliary power unit and the Northrop Grumman AAQ-24 Large Aircraft Infra-Red Countermeasures system. Originally planned for incorporation on 120 Galaxies, the RERP was scaled back to include a single C-5A, two C-5Cs and 49 C-5Bs. Once modified, the aircraft were assigned the designation C-5M and the popular name Super Galaxy. The C-5A fleet was phased out and the final example was retired on September 7, 2017.

Lockheed Martin delivered the final C-5M to the Air Force on August 2, 2018. The 52-aircraft fleet includes two C-5As that were originally modified to transport US Air Force and NASA space program cargo under the designation C-5C. After the RERP modifications were completed on the C-5Cs they became known as C-5M Space Cargo Modified aircraft.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
9th AS	Dover Air Force Base, Delaware	C-5M	436th AW/ OG	AMC	
22nd AS	Travis Air Force Base, California	C-5M	60th AMW/OG	AMC	
Air Force Reserve Command units					
312th AS (see Note 1)	Travis Air Force Base, California	C-5M	349th AMW/OG	AMC	
68th AS	Joint Base San Antonio-Lackland (Kelly Field), Texas	C-5M	433rd AW/ OG	AMC	
326th AS (see Note 1)	Dover Air Force Base, Delaware	C-5M	512th AW/ OG	AMC	
337th AS	Westover ARB, Massachusetts	C-5M	439th AW/ OG	AMC	
356th AS (FTU)	Joint Base San Antonio-Lackland (Kelly Field), Texas	C-5M	433rd AW/ OG	AMC	

Note
1 Classic associate squadron utilises aircraft assigned to host wing.

The Air Force's FY2021 budget provided over $50 million for avionics-related upgrades for the C-5M fleet. A Communication Navigation Surveillance/Air Traffic Management upgrade includes ADS-B Out capability, IFF mode 5, and replacement of the aircraft's satellite communication equipment and beyond line-of-sight voice radio. Serving as the baseline for all future C-5M modifications the Core Mission Computer/Weather Radar upgrade will provide a new Core Mission Computer, and the Collins Aerospace WXR-2100 weather radar will replace the aircraft's Honeywell APS-133 weather radar.

The Super Galaxy has a service life of 51,025 flight hours and is expected to remain in service until 2040 or beyond.

KC-10A Extender

The KC-10A has served the Air Force as a multi-role transport-tanker since the first example entered service at March Air Force Base, California, in October 1981. Known as the Extender, the aircraft is based on the airframe of the McDonnell Douglas DC-10 airliner. McDonnell Douglas delivered the 60th and final KC-10A to the Air Force in November 1988.

Serving as a tanker and cargo transport, the Extender delivered the capability to refuel aircraft while carrying support personnel and equipment on overseas deployments. The KC-10A is capable of transporting up to 75 personnel and nearly 170,000lb of cargo around 4,400 miles without refuelling. In its tanker role, the KC-10A can carry more than 356,000lb of fuel.

The fleet of 56 Extenders is based at Joint Base McGuire-Dix-Lakehurst, New Jersey and Travis Air Force Base, California, and flown and maintained by four Air Force and four Air Force Reserve Command associate squadrons.

The KC-10A features both an aerial refuelling boom and an internal hose-and-drogue refuelling system that permits the Extender to refuel a wide variety of US and allied military aircraft during a single mission. Additionally, the aircraft can be equipped with wing-mounted hose-and-drogue pods.

The entire fleet received a Communication Navigation Surveillance/Air Traffic Management (CNS/ATM) upgrade that was completed in March 2017. The mods, which replaced much of the aircraft's original avionics with the Rockwell Collins Flight2 integrated avionics system, were carried out by Field Aviation at its facility in Oklahoma City, Oklahoma. The upgrades made the Extenders compliant with new CNS/ATM mandates for accessing global airspace.

The Air Force began retiring the KC-10A fleet on July 13, 2020 when the first example arrived at Davis-Monthan Air Force Base, Arizona, for storage with the 309th Aerospace Maintenance and Regeneration Group. Two additional Extenders were retired by the end of FY2020. Despite the initial retirements, and plans to divest the fleet by 2024, planned upgrades will incorporate a Mode 5 IFF system and FAA-mandated ADS-B upgrades.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
2nd ARS	Joint Base McGuire-Dix-Lakehurst, New Jersey	KC-10A	305th AMW/OG	AMC	
6th ARS	Travis Air Force Base, California	KC-10A	60th AMW/ OG	AMC	
9th ARS	Travis Air Force Base, California	KC-10A	60th AMW/ OG	AMC	
32nd ARS	Joint Base McGuire-Dix-Lakehurst, New Jersey	KC-10A	305th AMW/OG	AMC	
Air Force Reserve Command units					
70th ARS (see Note 1)	Travis Air Force Base, California	KC-10A	349th AMW/OG	AMC	
76th ARS (see Note 1)	Joint Base McGuire-Dix-Lakehurst, New Jersey	KC-10A	514th AMW/OG	AMC	
78th ARS (see Note 1)	Joint Base McGuire-Dix-Lakehurst, New Jersey	KC-10A	514th AMW/OG	AMC	
79th ARS (see Note 1)	Travis Air Force Base, California	KC-10A	349th AMW/OG	AMC	

Note 1 Classic associate squadron utilises aircraft assigned to host wing.

Collins received Technology Maturation and Risk Reduction and Engineering and Manufacturing and Development contracts in March and November 2017. Aircraft modifications will be carried out by L2 Aviation under a sub-contract from Collins, which holds the Supplementary Type Certificate for the avionics suite.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
DIA Air Operations (see Note 1)	Wright-Patterson Air Force Base, Ohio	C-12C, C-12D	AFSAC/HQ DIA	AFMC	
DSCA (see Note 1)	Wright-Patterson Air Force Base, Ohio	C-12C, C-12D	AFSAC	AFMC	
Det 1, 517th AS	Joint Base Elmendorf-Richardson, Alaska	C-12F	3rd Wing/OG	PACAF	
1st AS	Joint Base Andrews-NAF Washington, Maryland	C-12C	89th AW/OG	AMC	
419th FLTS (see Note 2)	Edwards Air Force Base, California	C-12C	412th TW/OG	AFMC	ED
459th AS	Yokota Air Base, Japan	C-12J	374th AW/OG	PACAF	
586th FLTS	Holloman Air Force Base, New Mexico	C-12J	AEDC/704th TESTG	AFMC	HT
v					
185th SOS	Will Rogers Air National Guard Base/World Airport, Oklahoma City, Oklahoma	MC-12W	137th SOW/ SOG	AFSOC	

Notes
1 DIA/DSCA aircraft operated from numerous worldwide sites.
2 419th FLTS is also the FTU for the US Air Force C-12C/D.

Beechcraft C-12C, C-12D, C-12F, C-12J Huron, MC-12W Liberty

The Air Force operates several variants of the Beechcraft King Air. The oldest examples include the survivors of 31 B200 versions acquired to fulfil its CX-X requirement in 1975. Initially assigned the designation C-12A, the aircraft were designated as C-12Cs after being updated with more powerful Pratt & Whitney Canada PT6A turboprop engines. Six King Air B200s that followed were assigned the designation C-12D. Today the fleet comprises 16 C-12Cs and six C-12Ds that support US embassies and defence attaches via the Defense Intelligence Agency and Defense Security Co-operation Agency. C-12Cs are also assigned to the 412th Test Wing's 419th Flight Test Squadron at Edwards Air Force Base, California, where they support test and evaluations and training conducted by the US Air Force Test Pilot School. The squadron is also tasked as the formal training unit for the C-12.

Beginning in 1984, the Air Force acquired 46 King Air B200Cs and six B1900C airliners under the designations C-12F and C-12J. Initially assigned to the Operational Support Airlift role, the aircraft were later pressed into service as companion trainers. The majority of the fleet was transferred to the US Army in 1996. The Air Force inventory currently includes single examples of the C-12F and C-12J that are assigned to Air Force Materiel Command, while Pacific Air Forces operates two of the former and three of the latter.

The Air Force acquired the first of 42 King Air 350ER aircraft that were modified for the intelligence, surveillance, and reconnaissance (ISR) role in November 2008. The manned ISR platforms were acquired in response to urgent requirements in Afghanistan and Iraq. Modified under 'Project Liberty', the King Airs were assigned the designation MC-12W. Modifications were carried out by L3 Communications Integrated Systems and the first MC-12W arrived at the Mississippi Air National Guard's Key Field facility in Meridian on April 28, 2009.

The Liberty aircraft were equipped with several sensors and systems that included an electro-optical/ infra-red turret with a laser pointer. The King Airs arrived in Iraq and Afghanistan in June and December 2009, respectively. The final Air Force MC-12W mission was flown in Afghanistan in October 2014. While serving with the Air Force, the MC-12Ws flew over 400,000 combat hours and completed more than 79,000 combat sorties in Iraq and Afghanistan.

As a result of the drawdown of operations in Afghanistan, the Air Force divested most of the MC-12Ws. Although the majority were transferred to US Special Operations Command, at least eight were reassigned to the US Army. The Air Force retained just 13 MC-12Ws that are assigned to the Oklahoma Air National Guard's 137th Special Operations Wing beginning in July 2015. The 9th Reconnaissance Wing flew the final active-duty US Air Force MC-12W from Beale Air Force Base, California, on September 16, 2015. The MC-12Ws are currently being upgraded with Infrared Suppression Systems and MX-15 imaging systems.

C-17A Globemaster III

The C-17A entered operational service with the 437th Airlift Wing at Charleston Air Force Base, South Carolina in June 1993 and achieved initial operational capability in January 1995. Boeing, which acquired McDonnell Douglas in 1997, delivered the last of 223 Globemaster IIIs to the same base in September 2013. Development of the C-17A began after McDonnell Douglas was selected as the winner of the US Air Force's C-X competition in August 1981. The prototype first flew in September 1991 after a lengthy development period. The Globemaster III has proven to be a very capable aircraft and is unique in its ability to conduct both inter and intra-theatre missions. That capability permits it to deliver troops and cargo to main operating bases or directly to forward, austere airfields and perform tactical airlift and airdrop missions. Powered by four Pratt & Whitney F117-PW-100 turbofan engines, the C-17A can carry up to 102 troops, 36 litter patients, or 18 standard 463L cargo pallets.

Since entering service, the fleet has received numerous upgrades that included the integration of the large infrared countermeasures system and new weather radar.

The fleet of 222 C-17As is flown by 11 active-duty, 13 Air Force Reserve Command and seven Air National Guard airlift squadrons from 17 locations. One Air National Guard squadron and nine of the Air Force Reserve Command squadrons share the responsibility for operating and maintaining aircraft assigned to active-duty squadrons as associates organizations. Additionally, one active associate squadron operates alongside an Air National Guard unit. The airlifters are also flown by two training, one flight test and a weapons squadron.

The Air Force recently completed Block 21 upgrades on the C-17A that installed hardware and software associated with the ADS-B Out system. Block 21 modifications also include IFF modifications and additional communication/ navigation capability and software updates that improved the aircraft's flight management systems. Planned updates will provide improvements to the aircraft's beyond the line-of sight communications capabilities and incorporation of a replacement head-up display will begin in FY2021.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
3rd AS	Dover Air Force Base, Delaware	C-17A	436th AW/OG	AMC	
4th AS	Joint Base Lewis-McChord, Washington	C-17A	62nd AW/OG	AMC	
6th AS	Joint Base McGuire-Dix-Lakehurst, New Jersey	C-17A	305th AMW/OG	AMC	
7th AS	Joint Base Lewis-McChord, Washington	C-17A	62nd AW/OG	AMC	
8th AS	Joint Base Lewis-McChord, Washington	C-17A	62nd AW/OG	AMC	
14th AS	Joint Base Charleston, South Carolina	C-17A	437th AW/OG	AMC	

C-20H Gulfstream IV

The only C-20 series aircraft remaining on the Air Force inventory is based at Hanscom Air Force Base, Massachusetts, where it is operated by the Massachusetts Institute of Technology Lincoln Laboratory's flight test facility. The C-20H is under the control of the Air Force Rapid Capabilities Office in Washington D.C. and carries the civil registration N108EW. It is operated as a test platform in support of the Air Force Life Cycle Management Center. The C-20H is one of two Gulfstream IVs purchased by the Air Force until their retirement in September 2017. The second C-20H was transferred to the US Army Corps of Engineers.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
AFLCMC (See Note 1)	Hanscom Air Force Base, Massachusetts	C-20H		AFMC	

Note
1 C-20H operated by Massachusetts Institute of Technology — Lincoln Laboratory.

15th AS	Joint Base Charleston, South Carolina	C-17A	437th AW/OG	AMC	
16th AS	Joint Base Charleston, South Carolina	C-17A	437th AW/OG	AMC	
21st AS	Travis Air Force Base, California	C-17A	60th AMW/OG	AMC	
57th WPS (see Note 1)	Joint Base Lewis McChord, Washington	C-17A	57th Wing/ US Air Force Weapon School	ACC	
58th AS (FTU)	Altus Air Force Base, Oklahoma	C-17A	97th AMW/OG	AETC	
418th FLTS	Edwards Air Force Base, California	C-17A	412th TW/OG	AFMC	
517th AS (see Note 2)	Joint Base Elmendorf-Richardson, Alaska	C-17A	3rd Wing/OG	PACAF	AK
535th AS	Joint Base Pearl Harbor-Hickam, Hawaii	C-17A	15th Wing/OG	PACAF	HH
Air National Guard units					
204th AS (see Note 3)	Joint Base Pearl Harbor-Hickam, Hawaii	C-17A	154th Wing/OG	PACAF	HH
144th AS	Joint Base Elmendorf-Richardson, Alaska	C-17A	176th Wing/OG	PACAF	AK
137th AS	Stewart International Airport/Air National Guard Base, Newburgh, New York	C-17A	105th AW/OG	AMC	
155th AS	Memphis International Airport, Tennessee	C-17A	164th AW/OG	AMC	
156th AS	Charlotte Douglas International Airport, North Carolina	C-17A	145th AW/OG	AMC	
167th AS	Eastern West Virginia Regional Airport/ Shepherd Air National Guard Base, Martinsburg, West Virginia	C-17A	167th AW/OG	AMC	
183rd AS	Jackson International Airport-Allen C. Thompson Field, Mississippi	C-17A	172nd AW/OG	AMC	
Air Force Reserve Command units					
89th AS	Wright-Patterson Air Force Base, Ohio	C-17A	445th AW/OG	AMC	
97th AS	Joint Base Lewis-McChord, Washington	C-17A	446th AW/OG	AMC	
300th AS (See Note 4)	Joint Base Charleston, South Carolina	C-17A	315th AW/OG	AMC	
301st AS (See Note 4)	Travis Air Force Base, California	C-17A	349th AMW/OG	AMC	
313th AS (See Note 4)	Joint Base Lewis-McChord, Washington	C-17A	446th AW/OG	AMC	
317th AS (See Note 4)	Joint Base Charleston, South Carolina	C-17A	315th AW/OG	AMC	
701st AS (See Note 4)	Joint Base Charleston, South Carolina	C-17A	315th AW/OG	AMC	
709th AS (See Note 4)	Dover Air Force Base, Delaware	C-17A	512th AW/OG	AMC	
728th AS (See Note 4)	Joint Base Lewis-McChord, Washington	C-17A	446th AW/OG	AMC	
729th AS	March ARB, California	C-17A	452nd AMW/OG	AMC	
730th AMTS (See Note 5)	Altus Air Force Base, Oklahoma	C-17A	507th ARW/OG	AETC	
732nd AS (See Note 4)	Joint Base McGuire-Dix-Lakehurst, New Jersey	C-17A	514th AMW/OG	AMC	
758th AS	Pittsburgh Air Reserve Station/International Airport, Pennsylvania	C-17A	911th AW/OG	AMC	

Notes
1 57th WPS utilises aircraft assigned to host wing.
2 Squadron operates C-17A as an active associate to the co-located 144th AS.
3 Squadron operates C-17A as an associate to the co-located 535th AS.
4 Classic associate squadron utilises aircraft assigned to host wing.
5 Classic associate squadron supports 97th AMW C-17 training operations.

C-21A Learjet

The Air Force has operated the Learjet 35A in the operational support airlift role, under the designation C-21A since April 1984, when the first aircraft was delivered. The service initially leased 80 C-21As from Gates Learjet under a five-year contract as replacements for older Rockwell CT-39As. Four additional Learjets were later added to the Air National Guard inventory. The jets, which provided high-priority, time-sensitive transportation for cargo and passengers, were eventually purchased outright at the conclusion of the lease.

Today, the 19 C-21As that remain in service are compatible with the FAA's Next Generation Air Transport System following an avionics modernization program under a $32.2 million contract awarded in May 2017. First flight was in mid-2018 with the project completed in mid-2020.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
76th AS	Ramstein Air Base, Germany	C-21A	86th AW/OG	USAFE	
458th AS (FTU)	Scott Air Force Base, Illinois	C-21A	375th AW/OG	AMC	

Note 1 The 457th AS at Joint Base Andrews, Maryland, was inactivated in June 2019.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
PAS	Joint Base Andrews-NAF Washington, Maryland	VC-25A	89th AW/PAG	AMC	

VC-25A

A pair of Boeing 747-200B airliners supports the presidential airlift mission under the designation VC-25A. Equipped to an identical configuration, the jets feature an executive suite comprising a stateroom, a conference/ dining room, medical facility, and president's office. Seating and work areas for senior staff and security personnel, and members of the news media is also provided. The aircraft is also equipped with an advanced communications suite that permits the president to remain in constant contact with other senior leaders.

Purchased in 1982 the VC-25A flew its first mission as 'Air Force One' in September 1990. The aircraft are operated by the 89th Airlift Wing's Presidential Airlift Group and are based near the capital at Joint Base Andrews in Maryland. The VC-25As are flown and staffed by dedicated aircrew from the Presidential Airlift Squadron.

Boeing continues development of the 747-8-based replacement for the VC-25A under the US Air Force's Presidential Aircraft Recapitalization (PAR) program. The platform was selected in January 2015 and assigned the designation VC-25B. Boeing began risk reduction activities in support of the program in July 2016 and preliminary design work commenced when Boeing received a $600-million contract in September 2017. In July 2018, the program was formalised when Boeing was awarded a $3.9 billion contract.

Rather than acquiring new airframes for the PAR program, the Air Force purchased two 747-85M series aircraft from Boeing. The airliners had been ordered by Transaero Airlines in December 2013 but were never delivered to the airline, which filed for bankruptcy and ceased operations in October 2015. The configuration of the next-generation presidential aircraft will be similar to the VC-25A.

Boeing began making structural modifications to the airframes in February 2020 at its San Antonio, Texas, facility and the VC-25Bs will be delivered by December 2024 and the VC-25As will be retired no later than December 31, 2025.

The VC-25 Block upgrades ensure that the current aircraft can remain viable until the VC-25B program reaches full operational capability. Current upgrades include advanced satellite communications, weather radar, digital/voice data systems, and network capabilities. Integration of the Senior Leader Command Control Communication System modifications will begin in FY2021. Upgrades include VIPSAM Protected SATCOM, Presidential Information Technology Communication, Wi-Fi and commercial internet, Multi-Role Tactical Common Data Link, Mobile User Objective System and High Definition Video Teleconference.

ABBREVIATIONS

AACS	Airborne Air Control Squadron
AAF	Army Air Field
AATC	Air National Guard/Air Force Reserve Command Test Center
AATTC	Advanced Airlift Tactics Training Center
AB	Air Base
ACA	Aerospace Control Alert
ACC	Air Combat Command
ACCS	Airborne Command Control Squadron
ACTS	Air Combat Training Squadron
ACG	Air Control Group
ACW	Air Control Wing
ADS	Air Demonstration Squadron
AESG	Aeronautical Systems Group
AESS	Aeronautical Systems Squadron
AETC	Air Education and Training Command
AFDW	Air Force District of Washington
AFGSC	Air Force Global Strike Command
AFSAC	Air Force Security Assistance and Cooperation Directorate
AFSOAWC	Air Force Special Operations Air Warfare Center
AFSOC	Air Force Special Operations Command
AFB	Air Force Base
AFMC	Air Force Materiel Command
AFRC	Air Force Reserve Command
AFTC	Air Force Test Center
AG	Airlift Group
AGRS	Aggressor Squadron
AMARG	Aerospace Maintenance and Regeneration Group
AMC	Air Mobility Command
AMTS	Air Mobility Training Squadron
AMW	Air Mobility Wing
ANG	Air National Guard
ANGB	Air National Guard Base

RC-26B Condor

Based on the SA227DC Metroliner, the Air Force's 11 Fairchild Aircraft RC-26Bs are tasked in the ISR role. The Metroliners were originally configured for the Operational Support Airlift mission and flew that mission until 1996.

They were modified to accommodate a removable reconnaissance pod and operator station that had allowed the C-26Bs to support the National Guard's counter-drug mission. The transition to ISR and tasking of additional duties resulted in the assignment of the designation RC-26B.

Today the RC-26Bs support homeland operations by providing incident awareness and assessment for disaster response, national special security events , border operations, and counter drug missions in support of other government agencies including US Customs and Border Protection, the Federal Emergency Management Agency and the Drug Enforcement Agency. Additionally, they have been tasked to support Combatant Commands and overseas contingency operations .

The aircraft are normally flown by two pilots and a mission systems officer that operates the on board sensors and communications suite.

M7 Aerospace is currently carrying out an avionics update at its San Antonio, Texas, facility that provides upgrades to the electronic flight information displays, global positioning, flight management navigation and communication systems.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
Air National Guard units					
Det 1, 130th AS	Harrison/Marion Regional Airport, West Virginia	RC-26B	130th AW/OG	AMC	
100th FS	Montgomery Regional Airport-Dannelly Field, Alabama	RC-26B	187th FW/OG	ACC	
111th ATKS	Ellington Field JRB, Houston, Texas	RC-26B	147th ATKW/OG	ACC	
116th ARS	Fairchild Air Force Base, Washington	RC-26B	141st ARW/OG	AMC	
124th ATKS	Des Moines International Airport, Iowa	RC-26B	132nd Wing/OG	ACC	
214th ATKS	Tucson International Airport, Arizona	RC-26B	162nd Wing/ 214th ATKG	AETC	
153rd ARS	Meridian Regional Airport-Key Field, Mississippi	RC-26B	186th ARW/OG	AMC	
176th FS	Dane County Regional Airport-Truax Field, Madison, Wisconsin	RC-26B	115th FW/OG	ACC	
188th RQS	Kirtland Air Force Base, New Mexico	RC-26B	150th SOW/OG	AFSOC	
194th FS	Fresno-Yosemite International Airport/ Air National Guard Base, California	RC-26B	144th FW/OG	ACC	

C-32A, C-32B

The Air Force selected Boeing's 757-200ER airliner to replace the VC-137 (Boeing 707) used in the Special Air Mission role, in August 1996. The 89th Airlift Wing accepted the first of four modified 757-2G4 models in June 1998.

Assigned the designation C-32A, the aircraft are equipped to carry up to 45 passengers and a crew of 16 and are normally tasked to transport the vice president, cabinet members and members of Congress traveling on government business. They are outfitted with a communications centre, a fully enclosed stateroom, conference and staff facility and business-class seating for 32 passengers. When serving as presidential and vice presidential transports the C-32As are assigned the call sign 'Air Force One' or 'Air Force Two'.

In addition to the original C-32As, the wing's 1st Airlift Squadron is responsible for three 757-2Q8 models that were acquired from commercial sources in 2010 and are not formally carried on the Air Force inventory.

The service also acquired a pair of 757-23A aircraft that are operated by the New Jersey Air National Guard in support of US Special Operations Command, under the designation C-32B. A second pair of C-32Bs is operated on behalf of the US State Department's Foreign and Domestic Emergency Support Teams by the 486th Flight Test Squadron.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
1st AS	Joint Base Andrews-NAF Washington, Maryland	C-32A	89th AW/OG	AMC	
486th FLTS	Eglin Air Force Base, Florida	C-32B	AFMC	AFMC	
Air National Guard units					
150th SOS (see Note 1)	Joint Base McGuire-Dix-Lakehurst, New Jersey	C-32B	108th Wing/OG	AFSOC	

Note 1 AFSOC-gained squadron is assigned to AMC-gained wing.

C-37A, C-37B, EC-37B

The Air Force acquired nine C-37As and five C-37Bs (Gulfstream 550s). The two most recent additions were delivered to the 89th Airlift Wing in December 2019 and March 2020. Two additional C-37Bs, funded under the FY2020 National Defense Authorization Agreement, will be delivered by September 2021.

The Air Force recently disclosed plans to acquire as many as six additional G550s over a ten-year period. Its objective includes up to 22 C-37A and C-37Bs with a minimum requirement of 17 to support VIP/ Special Air Mission requirements.

In 2017, the G550 was selected as the host airframe for the Air Force's Compass Call electronic warfare suite, the primary wide-area coverage airborne electronic attack offensive counter information system.

Plans call for replacing Air Combat Command's fleet of 14 EC-130Hs with 10 EC-37Bs that will utilise the airframe of the G550 Conformal Airborne Early Warning derivative. The jets will receive the equipment as part of a 're-host' program that will 'cross-deck' the Compass Call equipment from the EC-130H to the Gulfstreams. BAE Systems, which serves as the Compass Call mission integrator began working on the project in September 2017.

BAE Systems is working with L3Harris, which has already removed prime mission equipment from several EC-130Hs under a separate contract. Around 70% of those systems will be reused on the new EC-37B Compass Call.

The initial five EC-37Bs will be delivered in Baseline 3 configuration and the subsequent deliveries will comprise Baseline 4 variants. Fielding of Baseline 3 variant is expected to begin in 2023 with Baseline 4 following in 2026.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
65th AS	Joint Base Pearl Harbor-Hickam, Hawaii	C-37A	15th Wing/OG	PACAF	
76th AS	Ramstein Air Base, Germany	C-37A	86th AW/OG	US Air Force	
99th AS	Joint Base Andrews-NAF Washington, Maryland	C-37A, C-37B	89th AW/OG	AMC	

C-40B, C-40C Clipper

The Air Force operates 11 737-700 Boeing Business Jets in two versions that carry the designations C-40B and C-40C and the popular name Clipper. The C-40B features the 737-800's strengthened wing and landing gear but unlike the US Navy's C-40As, they are not equipped to carry cargo. Operated by a crew of 11, the C-40Bs featured a VIP cabin, winglets, and extended-range fuel tanks that make them capable of intercontinental range. Capable of carrying up to 26 passengers in support of global operations, the jets are often tasked as support aircraft for Combatant Commanders. The first C-40B was handed over to the 89th Airlift Wing at Andrews Air Force Base, Maryland, in January 2003.

The Air Force acquired the first of two B737-7CPs, from commercial sources, in September 2002. The aircraft were delivered to the District of Columbia Air National Guard's 113th Wing and replaced several C-22Bs (Boeing 727s) operated by the 201st Airlift Squadron.

Four additional C-40Cs are operated by Air Force Reserve Command's 73rd Airlift Squadron at Scott Air Force Base, Illinois. The squadron is supported by an active associate squadron assigned to the 375th Air Mobility Wing at Scott.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
1st AS	Joint Base Andrews-NAF Washington, Maryland	C-40B	89th AW/OG	AMC	
54th AS (see Note 1)	Scott Air Force Base, Illinois	C-40C	375th AMW/OG	AMC	
Air National Guard units					
201st AS (see Note 2)	Joint Base Andrews-NAF Washington, Maryland	C-40C	113th Wing/OG	AMC	
Air Force Reserve Command units					
73rd AS	Scott Air Force Base, Illinois	C-40C	932nd AW/OG	AMC	

Notes
1 Active associate squadron shares responsibility for C-40C aircraft assigned to Air Force Reserve Command's 932nd AW.
2 Wing is ACC gained.
3 US Air Force C-40B reassigned to 89th AW in June 2019.

Air Education and Training Command's 97th Air Mobility Wing based at Altus Air Force Base, Oklahoma is the KC-46 schoolhouse. The wing received its first KC-46A Pegasus tanker on February 8, 2019. US Air Force/ Senior Airman Cody Dowell

KC-46A Pegasus

Boeing's 767-200 commercial freighter was named the winner of the Air Force's protracted KC-X project in February 2011. Assigned the designation KC-46A, the Pegasus is based on the 767-2C commercial freighter. It was developed under a $3.5 billion Engineering and Manufacturing Development (EMD) contract that provided for production of four developmental aircraft.

The KC-46A will primarily be tasked with the aerial refuelling mission but will be fully capable of carrying passengers and cargo and supporting aeromedical airlift missions.

The first of the four EMD aircraft carried out its inaugural flight in December 2014 in a (767-2LK) freighter configuration. The first fully configured tanker took to the air at Paine Field in Everett, Washington, on September 25, 2015.

The Pegasus is being developed under a fixed-price contract and due to development and certification delays Boeing has already absorbed around $4.8 billion in cost overruns. Boeing has already received production contracts for 67 tankers in the first five production lots. The most recent award occurred in September 2019. The initial five production lots included 7, 12, 15, 18 and 15 aircraft. Another 12 tankers were funded in FY2020 and 15 were requested in FY2021. Boeing received a $5.7 billion contract to develop future KC-46 tanker upgrades under the 10-year Pegasus Combat Capability program in April 2019.

Developmental Test and Evaluation was completed in early 2019 and Initial Operational Test and Evaluation began in May 2019. Despite issues with its remote vision system (RVS) and refuelling boom, the Air Force remains hopeful that the Pegasus will achieve full operational capability by 2023. Boeing is currently conducting a complete redesign of the RVS.

The KC-X project includes the purchase of 179 KC-46As that will be delivered by 2028. The first operational KC-46A was assigned to the 22nd Air Refueling Wing's (ARW's) 344th Air Refueling Squadron at McConnell Air Force Base, Kansas in January 2019. Pegasus training is carried out by the 97th Air Mobility Wing (AMW)at Altus Air Force Base, Oklahoma. The New Hampshire Air National Guard accepted its first KC-46A when serial 17-46029 was delivered to Pease Air National Guard Base on August 8, 2019. The first Pegasus for Air Force Reserve Command was delivered to the 916th ARW at Seymour Johnson Air Force Base, North Carolina, on June 12, 2020. Serial 15-46011 was the first of 12 tankers that will be delivered to the base.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
Det 1, 418th FLTS	King County International Airport/Boeing Field, Seattle, Washington	KC-46A	412th TW/OG	AFMC	
56th ARS	Altus Air Force Base, Oklahoma	KC-46A	97th AMW/OG	AETC	
344th ARS	McConnell Air Force Base, Kansas	KC-46A	22nd ARW/OG	AMC	
64th ARS	Pease Air National Guard Base Portsmouth International Airport, New Hampshire	KC-46A	22nd ARW/OG	AMC	
Air National Guard units					
133rd ARS	Pease Air National Guard Base Portsmouth International Airport, New Hampshire	KC-46A	157th ARW/OG	AMC	
Air Force Reserve Command units					
77th ARS (see Note 1)	Seymour Johnson Air Force Base, North Carolina	KC-46A	916th ARW/OG	AMC	
924th ARS (see Note 2)	McConnell Air Force Base, Kansas	KC-46A	931st ARW/OG	AMC	
730th AMTS (see Note 3)	Altus Air Force Base, Oklahoma	KC-46A	507th ARW/OG	AETC	

Notes
1 77th ARS received first KC-46A on June 12, 2020
2 Associate unit shares aircraft assigned to the 22nd ARW
3 Classic associate squadron supports 97th AMW KC-46A training operations.

Joint Base McGuire-Dix-Lakehurst, New Jersey and Travis Air Force Base, California were selected as the preferred locations for the next two main operating bases, where the KC-46A will replace the KC-10As currently assigned to the 305th and 22nd AMWs.

In October 2020, the commander of Air Mobility Command confirmed the Air Force plans to move forward with a full and open competition associated with the acquisition of a 'bridge tanker' to follow the KC-46A. The air-refuelling aircraft project was formerly known as 'KC-Y' and is considered a 'stepping stone' to a more advanced futuristic tanker. The tanker would allow the service to recapitalise additional KC-135s and bridge the gap in capabilities provided by the Pegasus and the as-yet undefined KC-Z. According to Air Mobility Command, the new tanker will be a 'non-developmental' program, and will be based on an existing, proven aircraft such as the KC-46A and the Airbus A330 Multi-Role Tamker Transport. It is likely that the Air Force will begin funding the next phase of its tanker recapitalisation in FY2002.

C-130H Hercules

Although the active-duty Air Force has fully transitioned to the C-130J, its Reserve components still operate a large number of C-130Hs. In addition, around 40 special mission variants continue to serve the active and reserve components. The C-130H primarily serves in the intra-theatre airlift role and the fleet currently includes 123 operated by Air National Guard (ANG) squadrons and 42 within the Air Force Reserve Command (AFRC). Additionally, two examples are assigned to Air Force Special Operations Command (AFSOC).

The Air Force's plan for 2021 include divestment of 13 ANG C-130Hs that will be partially offset by the transfer of eight C-130Js from the active component to the guard. The Air Force has not yet announced where the aircraft will be assigned but eight different units were under consideration. The FY2020 NDAA provided funding for eight C-130Js that would be divided evenly between the ANG and AFRC.

Although AFSOC retired its last AC-130U gun ship in June 2020, the command still retains 10 AC-130Ws on its inventory. Previously assigned the designation MC-130W, the Combat Spears were converted to gunship configuration beginning in 2010. In 2012 the aircraft was assigned the designation AC-130W and named Stinger II. AFSOC will retire four additional AC-130Ws in 2021 as additional AC-130Js enter the inventory. Both the AC-130U and AC-130W, which are based on the C-130H airframe are being replaced by 37 new AC-130Js.

The New York ANG operates ten ski-equipped LC-130Hs that support science operations in the Arctic and Antarctic. They include three aircraft that are owned by the National Science Foundation and were previously operated by the US Navy under the designation LC-130R.

The AFSOC MC-130H fleet was consolidated at Hurlburt Field, Florida, after the last Combat Talon II departed Kadena Air Base, Okinawa, Japan on December 19, 2019. Just 13 examples remained in service at the start of FY2021. AFSOC began retiring its Combat Talon IIs in September 2015 and six are currently stored at Davis-Monthan Air Force Base in Arizona.

The EC-130H Compass Call electronic warfare aircraft fleet currently includes 10 Mid-Baseline 2 (MBL2), Block 35 examples that are stationed at Davis-Monthan and operated by two Electronic Combat Squadrons. Retirement of the EC-130H Block Baseline 1 aircraft began in August 2018 and the final example was retired in 2020. The service began removing Compass Call equipment from retired EC-130Hs in order to transfer (or cross-deck) it to a new fleet of EC-37B Gulfstreams that will begin entering service in 2023.

Although the service continues to add C-130Js to its fleet, the Air Force will continue to rely on the legacy Hercules models and planned upgrades will ensure the fleet remains relevant. The service has begun installing new eight-blade Collins Aerospace NP2000 propellers on the ANG aircraft. New York ANG's LC-130Hs as well as C-130Hs operated by the Wyoming ANG's 153rd Airlift Wing were the first to receive the systems. The National Guard Bureau has identified seven additional C-130H wings that will receive propeller and Series 3.5 engine upgrades that reduce fuel consumption and improve reliability for its T56 turboprops. Collins Aerospace Systems recently received a contract to deliver NP2000 propellers for 30 additional airlifters. The contract brings the total number of shipsets to 55 aircraft. Ultimately the service plans to upgrade 160 C-130Hs with the eight-blade propeller system.

The service has also begun a two-phase Avionics Modernization Program (AMP). Increment 1 permits the aircraft to meet ICAO GATM CNS/ATM mandates that went into effect on January 1, 2020.

Collins Aerospace Systems is also under contract to produce 176 AMP Increment 2 kits for the C-130H fleet. The contractor's Flight2 avionics system provides a new Flight Management System, seven multifunctional displays, three control display units, and a new digital autopilot. The aircraft will also receive a Terrain Awareness and Warning System, enhanced communications, and electrical improvements. Low rate initial production of AMP 2 will begin in FY2022 and is scheduled for completion in 2028.

C-130J Super Hercules

At the end of FY2020, the airlift inventory encompassed 134 C-130Js including several standard-length aircraft that support training at Little Rock Air Force Base, Arkansas. As the largest single operator, Air Mobility Command has 64 aircraft assigned. US Air Forces Europe, Pacific Air Forces and Air Education and Training Command (AETC) each have 14 C-130Js assigned. Another 18 are assigned to two Air National Guard (ANG) wings and the Air Force Reserve Command (AFRC) has ten.

AFRC also operates 10 standard-length C-130J airframes that were modified for weather reconnaissance missions under the designation WC-130J. The 'Hurricane Hunter' WC-130Js are tasked with penetrating tropical cyclones and hurricanes to collect high-accuracy weather data from within the storms. Five C-130Js were configured for electronic and special operations missions as EC-130Js. Two standard-length C-130Js that had initially been used in the airlift role were later modified for special operations duties under the EC-130J designation. Delivery of the first EC-130J to the Pennsylvania ANG's 193rd Special Operations Squadron (SOS) occurred in October 1999.

Development of two new special mission variants of the C-130J began under the HC-130/MC-130 Recapitalization program in June 2008. The first HC-130J flew in July 2010 and the MC-130J followed in April 2011. Tasked with combat rescue and special operations roles, the HC-130J and MC-130J models provide the capability to refuel helicopters and tiltrotors in flight. The new models initially replaced the HC-130P and MC-130E and MC-130P variants. Replacement of the last HC-130Ns with HC-130Js began in April 2020 at Patrick Air Force Base, Florida, when the first example was delivered to the AFRC's 920th Rescue Wing. The MC-130J will also replace Air Force Special Operations Ccommand's remaining Combat Talon IIs. Plans call for the purchase of 134 aircraft including 37 HC-130J Combat Kings. The current requirement includes 37 HC-130J Combat King IIs and 31 are in service with Air Combat Command, AETC and three ANG units.

Current MC-130J upgrades include integration and testing of the Airborne Mission Networking system. It provides the capability to send and receive mission-critical data to/from tactical and operational nodes in the battlespace. Among the other benefits it provides are secure line-of-sight/beyond line-of-sight voice/data communications, friendly force identification, mission tracking, threat identification, full-motion video, collaboration, chat, e-mail, integrated tactical map and data links. Developmental flight test and integration testing of MC-130Js equipped with the SOF Common APQ-187 Terrain Following/Terrain Avoidance Silent Knight Radar will be completed in 2021. MC-130J procurement plans include 37 airframes that will be converted to AC-130J gunship configuration.

The AC-130J first flew in Block 10 configuration at Eglin Air Force Base, Florida, in January 2013. Operated by a crew of seven, the Block 10 gunships featured dual MX-20 EO/IR sensors, GAU-23 30mm cannon and precision-guided munitions that included the AGM-176 Griffin missile and the 250lb GPS-guided GBU-39/B and laser guided GBU-39B/B Small Diameter Bombs.

The Block 20 system integrated with the fourth AC-130J added a 105mm cannon, a pilot helmet-mounted tactical display, and large aircraft infrared countermeasures. Block 20s were first deployed to US Central Command in June 2019 and initially flew combat missions over Afghanistan. The AC-130J Block 20+ upgrade provided the gunship with a permanent CSO station on the flight deck and the ability to employ wing-mounted AGM-114R2 Hellfire, laser-guided missiles and GBU-69 Small Glide Munitions. Installation of new RF countermeasures equipment in both the AC-130J and MC-130J will begin in FY2021.

On November 20, 2020, the Air Force announced plans to relocate AC-130J training from Hurlburt Field to Kirtland Air Force Base, New Mexico under the 58th Special Operations Wing. The move aligns gunship training with HC-130J and MC-130J training under AETC. Relocation of seven AC-130Js will begin in summer 2022.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
1st SOS (see Note 1)	Kadena Air Base, Okinawa, Japan	MC-130J	353rd SOG	AFSOC	
4th SOS	Hurlburt Field, Florida	AC-130U, AC-130J	1st SOW/ SOG	AFSOC	
9th SOS	Cannon Air Force Base, New Mexico	MC-130J	27th SOW/ SOG	AFSOC	
14th WPS (see Note 2)	Hurlburt Field, Florida	MC-130H, MC-130J, AC-130U, AC-130W	57th Wing/ US Air Force Weapon School	ACC	
15th SOS	Hurlburt Field, Florida	MC-130H, MC-130J	1st SOW/ SOG	AFSOC	
16th SOS	Cannon Air Force Base, New Mexico	AC-130W, C-130H2	27th SOW/ SOG	AFSOC	
19th SOS (FTU) (see Note 2)	Hurlburt Field, Florida	AC-130J, AC-130U, MC-130H	492nd SOW	AFSOC	
29th WPS (see Note 2)	Little Rock Air Force Base, Arkansas	C-130J	57th Wing/ USAFWS	ACC	
29th WPS Det 1 (see Note 2)	Rosecrans	C-130H	57th Wing/ USAFWS	ACC	
34th WPS (see Note 3)	Nellis Air Force Base, Nevada	HC-130J	57th Wing/ USAFWS	ACC	FT
36th AS	Yokota Air Base, Japan	C-130J	374th AW/ OG	PACAF	
37th AS	Ramstein Air Base, Germany	C-130J	86th AW/OG	USAFE	RS
39th AS	Dyess Air Force Base, Texas	C-130J	317th AW/ OG	AMC	
40th AS	Dyess Air Force Base, Texas	C-130J	317th AW/ OG	AMC	
41st AS	Little Rock Air Force Base, Arkansas	C-130J	19th AW/OG	AMC	
41st ECS	Davis-Monthan Air Force Base, Arizona	EC-130H	55th Wing/ ECG	ACC	DM
42nd ECS (FTU) (see Note 4)	Davis-Monthan Air Force Base, Arizona	(No aircraft assigned)	55th Wing/ ECG	ACC	DM
43rd ECS	Davis-Monthan Air Force Base, Arizona	EC-130H	55th Wing/ ECG	ACC	DM
61st AS	Little Rock Air Force Base, Arkansas	C-130J	19th AW/OG	AMC	
62nd AS (FTU) (see Note 5)	Little Rock Air Force Base, Arkansas	C-130J	314th AW/ OG	AETC	
67th SOS	RAF Mildenhall, Suffolk England	MC-130J	352nd SOW/752nd SOG	AFSOC	
71st RQS	Moody Air Force Base, Georgia	HC-130J	23rd Wing/347th RQG	ACC	FT
73rd SOS	Hurlburt Field, Florida	AC-130J	1st SOW/ SOG	AFSOC	
79th RQS	Davis-Monthan Air Force Base, Arizona	HC-130J	355th Wing/ 563rd RQG	ACC	DM
88th TES (see Note 6)	Nellis Air Force Base, Nevada	HC-130J	53rd Wing/ TEG	ACC	OT
96th OG Det. 1 (see Note 7)	Hurlburt Field, Florida.	MC-130H, AC-130U, AC-130J	96th TW/OG	AFMC	
415th SOS	Kirtland Air Force Base, New Mexico	HC-130J, MC-130J	58th SOW/ OG	AETC	
551st SOS (FTU) (see Note 7)	Cannon Air Force Base, New Mexico	AC-130W	492nd SOW/ SOG	AFSOC	
661st AESS	TSTC Airport, Waco, Texas	NEC-130H	645th AESG (see Note 8)	AFMC	
Air National Guard units					
AATTC (see Note 9)	Rosecrans Memorial Airport, St Joseph, Missouri	C-130H2.5	57th Wing/ USAFWS	ACC	
102nd RQS	Francis S. Gabreski Airport/ Air National Guard Base, Westhampton Beach, New York	HC-130J	106th RQW/ OG	ACC	LI
109th AS	Minneapolis St Paul International Airport/ARS, Minnesota	C-130H3	133rd AW/ OG	AMC	
115th AS	NB Ventura County/Point Mugu-Channel Islands Air National Guard Station, California	C-130J	146th AW/ OG	AMC	
118th AS	Bradley International Airport/Air National Guard Base, Windsor Locks, Connecticut	C-130H	103rd AW/ OG	AMC	
130th AS	Yeager Airport/McLaughlin Air National Guard Base, Charleston, West Virginia	C-130H3	130th AW/ OG	AMC	
130th RQS	Moffett Federal Airport Air National Guard Station, California	HC-130J	129th RQW/ OG	ACC	CA
139th AS	Schenectady County Airport/Stratton Air National Guard Station, Scotia, New York	C-130H2, LC-130H2, LC-130H3	109th AW/ OG	AMC	
142nd AS	New Castle County Airport, Delaware	C-130H2	166th AW/ OG	AMC	
143rd AS	Quonset State Airport/ Holland Air National Guard Base, N. Kingston, Rhode Island	C-130J	143rd AW/ OG	AMC	
154th TRS (FTU)	Little Rock Air Force Base, Arkansas	C-130H2	189th AW/ OG	AETC	
158th AS	Savannah Hilton Head International Airport, Georgia	C-130H2, C-130H3	165th AW/ OG	AMC	
164th AS	Mansfield Lahm Airport, Ohio	C-130H, C-130H2	179th AW/ OG	AMC	
165th AS	Louisville International Airport-Standiford Field, Kentucky	C-130H2.5	123rd AW/ OG	AMC	
169th AS	General Downing-Peoria International Airport, Illinois	C-130H3	182nd AW/ OG	AMC	
180th AS	Rosecrans Memorial Airport, St Joseph, Missouri	C-130H2.5	139th AW/ OG	AMC	
181st AS	NAS JRB Fort Worth/ Carswell Field, Texas	C-130H2, C-130H3	136th AW/ OG	AMC	
186th AS	Great Falls International Airport, Montana	C-130H, C-130H2	120th AW/ OG	AMC	
187th AS	Cheyenne Municipal Airport, Wyoming	C-130H2, C-130H3	153rd AW/ OG	AMC	
188th RQS (see Note 10)	Kirtland Air Force Base, New Mexico	HC-130J, MC-130J	150th SOW/ SOG	AETC	
192nd AS	Reno Tahoe International Airport/May Air National Guard Base, Nevada	C-130H2, C-130H3	152nd AW/ OG	AMC	
193rd SOS	Harrisburg International Airport, Pennsylvania	EC-130J	193rd SOW/ SOG	AFSOC	
211th RQS	Joint Base Elmendorf-Richardson, Alaska	HC-130J	176th Wing/ OG	PACAF	
Air Force Reserve Command units					
5th SOS (see Note 11)	Hurlburt Field, Florida	AC-130U	919th SOW/ SOG	AFSOC	
39th RQS	Patrick Air Force Base, Florida	HC-130J	920th RQW/ OG	ACC	FL
53rd WRS	Keesler Air Force Base, Mississippi	WC-130J	403rd Wing/ OG	AMC	
96th AS	Minneapolis-St Paul Air Reserve Station/ International Airport, Minnesota	C-130H3	934th AW/ OG	AMC	
327th AS (see Note 12)	Little Rock Air Force Base, Arkansas	C-130J	913th AG	AMC	
357th AS	Maxwell-Gunter Air Force Base, Alabama	C-130H2	908th AW/ OG	AMC	
700th AS	Dobbins Air Reserve Base, Georgia	C-130H3	94th AW/OG	AMC	
731st AS	Peterson Air Force Base, Colorado	C-130H3	302nd AW/ OG	AMC	
757th AS	Youngstown Air Reserve Station/Youngstown-Warren Regional Airport, Ohio	C-130H2	910th AW/ OG	AMC	
815th AS	Keesler Air Force Base, Mississippi	C-130J	403rd Wing/ OG	AMC	

Notes

1 Last MC-130H assigned to the 1st SOS departed Kadena Air Base on December 3, 2019. The squadron assumed responsibility for the MC-130Js from the 17th SOS on April 17, 2020. The 17th SOS was inactivated the same day.
2 Squadron utilises aircraft assigned to host wing.
3 34th WPS utilises HC-130Js operated by the 79th RQS at Davis-Monthan Air Force Base, Arizona.
4 Squadron utilises EC-130H assigned to the 41st and 43rd ECS in support of FTU mission.
5 C-130J training mission reassigned from the 48th AS to the 62nd AS on September 30, 2016.
6 Combat Search and Rescue Combined Task Force (CSAR/CTF). Squadron is located at Nellis Air Force Base but HC-130J based at Davis-Monthan Air Force Base, Arizona.
7 Utilises aircraft assigned to host wing.
8 645th AESG is based at Wright-Patterson Air Force Base, Ohio.
9 Utilises aircraft assigned to the 139th Airlift Wing.
10 Associate unit conducts training alongside the active duty 415th SOS.
11 Associate unit, shares aircraft with co-located active-duty squadron, which supports AFSOTC/19th SOS training efforts.
12 Classic associate unit, shares aircraft assigned to the 314th AW.

A ski-equipped LC-130H 63302 assigned to the 139th Expeditionary Airlift Squadron at McMurdo Station, Antarctica. LC-130s are deployed to Antarctica in support of the National Science Foundation's US Antarctic Program dubbed Operation Deep Freeze from the New York Air National Guard's 109th Airlift Wing at Scotia, New York. US Air National Guard

KC-135, NC-135, OC-135, RC-135, TC-135 Stratotanker and Stratolifter

With an average age exceeding 58 years, the Air Force's C-135s represent some of the oldest aircraft in its fleet. Despite their age, however, the aircraft are expected to serve through 2045. The KC-135A initially entered service with Strategic Air Command at Castle Air Force Base, California, in June 1957. The Air Force acquired more than 750 Stratotankers and Stratolifters when procurement ended in 1964. Although the final aircraft were delivered in 1965, over half of the jets remain in service. While the tanker variant was responsible for the bulk of production, the C-135 airframe was modified for numerous other missions. Currently the tankers include the KC-135R and KC-135T models and both variants are powered by four General Electric F108-GE-100 (CFM56) turbofans.

Eight KC-135R(RT) aircraft feature a refuelling receptacle and are referred to as refuellable tankers. A number of KC-135Rs compatible with wing-mounted Flight Refueling Limited (FRL) Mk32B hose-and-drogue air refuelling pods that permit the Stratotanker to refuel aircraft that are not compatible with the flying boom. The Stratotanker's main deck also permits it to carry passengers and/or cargo. In cargo configuration it can accommodate up to six standard 463L pallets.

Currently, 345 KC-135R and 52 KC-135T tankers are operated by active duty units, the Air National Guard (ANG) and Air Force Reserve Command (AFRC). The ANG remains the largest operator of the Stratotanker and flies 115 of the former and 24 of the latter. Active duty units within Air Mobility Command (AMC), Pacific Air Forces (PACAF), United States Air Forces Europe (USAFE) and Air Education and Training Command (AETC) operate the Stratotanker. Whereas AMC is responsible for 115 KC-135Rs and 23 KC-135Ts, PACAF operates 10 KC-135Rs, five KC-135Ts and USAFE has 11 KC-135Rs and a single KC-135T assigned. In addition, 17 KC-135Rs and one KC-135T support AETC's training efforts at Altus Air Force Base, Oklahoma. One KC-135R supports test and evaluation with Air Force Materiel Command (AFMC) at Edwards Air Force Base, California. AFRC's inventory is 67 KC-135Rs.

Stratolifters have been modified for a variety of specialised missions. Operated by Air Combat Command's 55th Wing at Offutt Air Force Base, Nebraska, the special mission fleet is part of the US Air Force's Manned Reconnaissance Systems Program. While the 55th Wing is stationed at Offutt Air Force Base, Nebraska, its aircraft are regularly deployed to worldwide forward operating locations.

The 55th Wing is currently responsible for the OC-135B, RC-135S, RC-135U, RC-135V, RC-135W, TC-135W and WC-135W models.

Three Baseline 6 configuration Cobra Ball RC-135S aircraft are tasked to collect optical and electronic data on ballistic targets. Planned Baseline 7 enhancements for the Cobra Ball will provide foreign instrumentation signals intelligence direction finding and digital data recording, digital search, target discrimination via SATCOM, and the integration of the Rivet Joint Baseline 12 Communications Intelligence suite.

A pair of RC-135U Combat Sent strategic electronic reconnaissance aircraft support the radar signals intelligence mission. The Combat Sent aircraft are in line to be upgraded to the latest Baseline 6 configuration that will improve wideband collection capability, scientific and technical processors, operator interfaces and integrate the Rivet Joint Baseline 13 communications intelligence suite. ACC's Rivet Joint aircraft are tasked with electronic intelligence missions. The Rivet Joint fleet is supported by a single NC-135W that is assigned to AFMC and serves as the development platform for upgrades.

Representing the majority variant, the RC-135V/W drives the baseline integration and modification upgrade strategy for the entire RC-135 fleet. Continuous upgrades for the RC-135 fleet will ensure the aircraft remain viable through 2050.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
38th RS	Offutt Air Force Base, Nebraska	RC-135V, RC-135W, TC-135W	55th Wing/OG	ACC	OF
45th RS	Offutt Air Force Base, Nebraska	WC-135W, OC-135B, RC-135S, RC-135U, TC-135S	55th Wing/OG	ACC	OF
Det 45th RS	Eielson Air Force Base, Alaska	RC-135S	55th Wing/OG	ACC	OF
50th ARS	MacDill Air Force Base, Florida	KC-135R	6th ARW/OG	AMC	
54th ARS (FTU)	Altus Air Force Base, Oklahoma	KC-135R	97th AMW/OG	AETC	
82nd RS	Kadena Air Base, Okinawa	RC-135V, RC-135W	55th Wing/OG	ACC	OF
91st ARS	MacDill Air Force Base, Florida	KC-135R, KC-135T	6th ARW/OG	AMC	
92nd ARS	Fairchild Air Force Base, Washington	KC-135R, KC-135T	92nd ARW/OG	AMC	
93rd ARS	Fairchild Air Force Base, Washington	KC-135R, KC-135T	92nd ARW/OG	AMC	
95th RS (see Note 1)	RAF Mildenhall, Suffolk, England	RC-135V, RC-135W	55th Wing/OG	ACC	OF
Det 1, 95th RS	NSA Souda Bay Air Base, Crete, Greece	RC-135V, RC-135W	55th Wing/OG	ACC	OF
99th ARS (see Note 2)	Birmingham-Shuttlesworth International Airport, Alabama	KC-135R	6th ARW/OG	AMC	
97th ARS	Fairchild Air Force Base, Washington	KC-135R	92nd ARW/OG	AMC	
338th CTS (FTU)	Offutt Air Force Base, Nebraska	(RC-135, OC-135, WC-135 training)	55th Wing/OG	ACC	OF
343rd RS	Offutt Air Force Base, Nebraska	RC-135V, RC-135W, TC-135W	55th Wing/OG	ACC	OF
344th ARS	McConnell Air Force Base, Kansas	KC-135R, KC-135T	22nd ARW/OG	AMC	
349th ARS	McConnell Air Force Base, Kansas	KC-135R, KC-135R(RT)	22nd ARW/OG	AMC	
350th ARS	McConnell Air Force Base, Kansas	KC-135R	22nd ARW/OG	AMC	
351st ARS	RAF Mildenhall, Suffolk, England	KC-135R, KC-135T	100th ARW/OG	US Air Force	
384th ARS	Fairchild Air Force Base, Washington	KC-135R	92nd ARW/OG	AMC	
418th FLTS	Edwards Air Force Base, California	KC-135R	412th TW/OG	AFMC	
509th WPS (see Note 3)	Fairchild Air Force Base, Washington	KC-135R	57th Wing/USAFWS	ACC	
645th AESS (see Note 4)	Majors Field Greenville Municipal Airport, Texas	NC-135W	645th AESG (see Note 5)	AFMC	
906th ARS (see Note 5)	Scott Air Force Base, Illinois	KC-135R	305th AMW/OG	AMC	
909th ARS	Kadena Air Base, Okinawa	KC-135R	18th Wing/OG	PACAF	
912th ARS (see Note 6)	March ARB, California	KC-135R	92nd ARW/OG	AMC	
Air National Guard units					
106th ARS	Birmingham-Shuttlesworth International Airport, Alabama	KC-135R	117th ARW/OG	AMC	
108th ARS	Scott Air Force Base, Illinois	KC-135R	126th ARW/OG	AMC	
116th ARS (see Note 7)	Fairchild Air Force Base, Washington	KC-135R	141st ARW/OG	AMC	
117th ARS	Topeka Regional Airport - Forbes Field Air National Guard Base, Kansas	KC-135R	190th ARW/OG	AMC	
126th ARS	Gen. Mitchell International Airport/ARS, Milwaukee, Wisconsin	KC-135R	128th ARW/OG	AMC	
132nd ARS	Bangor International Airport, Maine	KC-135R	101st ARW/OG	AMC	
141st ARS	Joint Base McGuire-Dix-Lakehurst, New Jersey	KC-135R	108th Wing/OG	AMC	
146th ARS	Pittsburgh International Airport, Pennsylvania	KC-135T	171st ARW/OG	AMC	
147th ARS	Pittsburgh International Airport, Pennsylvania	KC-135T	171st ARW/OG	AMC	
151st ARS	McGhee Tyson Airport/Air National Guard Base, Knoxville, Tennessee	KC-135R	134th ARW/OG	AMC	
153rd ARS	Meridian Regional Airport-Key Field, Mississippi	KC-135R	186th ARW/OG	AMC	
166th ARS	Rickenbacker International Airport/Air National Guard Base, Columbus, Ohio	KC-135R	121st ARW/OG	AMC	
168th ARS	Eielson Air Force Base, Alaska	KC-135R	168th Wing/OG	PACAF	
171st ARS	Selfridge Air National Guard Base, Mount Clemens, Michigan	KC-135T	127th Wing/OG	AMC	
173rd ARS	Lincoln Municipal Airport/Air National Guard Base, Nebraska	KC-135R	155th ARW/OG	AMC	
174th ARS	Sioux Gateway Airport/Col Bud Day Field, Sioux City, Iowa	KC-135R	185th ARW/OG	AMC	
191st ARS	Roland R. Wright Air National Guard Base/Salt Lake City International Airport, Utah	KC-135R	151st ARW/OG	AMC	
197th ARS	Goldwater Air National Guard Base/Phoenix Sky Harbor International Airport, Arizona	KC-135R	161st ARW/OG	AMC	
203rd ARS	Joint Base Pearl Harbor-Hickam, Hawaii	KC-135R	154th Wing/OG	PACAF	
238th CTS (FTU) (Note 8)	Offutt Air Force Base, Nebraska	RC-135, OC-135	170th Group	ACC	OF
Air Force Reserve Command units					
18th ARS (see Note 9)	McConnell Air Force Base, Kansas	KC-135R	931st ARW/OG	AMC	
63rd ARS	MacDill Air Force Base, Florida	KC-135R	927th ARW/OG	AMC	
72nd ARS	Grissom ARB, Indiana	KC-135R	434th ARW/OG	AMC	
74th ARS	Grissom ARB, Indiana	KC-135R	434th ARW/OG	AMC	
314th ARS	Beale Air Force Base, California	KC-135R	940th ARW/OG	AMC	

328th ARS	Niagara Falls ARS/ International Airport, New York	KC-135R	914th ARW/ OG	AMC	
336th ARS	March ARB, California	KC-135R	452nd AMW/ OG	AMC	
465th ARS	Tinker Air Force Base, Oklahoma	KC-135R	507th ARW/ OG	AMC	
730th AMTS (See Note 10)	Altus Air Force Base, Oklahoma	KC-135R	507th ARW/ OG	AETC	
756th ARS	Joint Base Andrews-NAF Washington, Maryland	KC-135R	459th ARW/ OG	AMC	
905th ARS (see Note 9)	McConnell Air Force Base, Kansas	KC-135R	931st ARW/ OG	AMC	

Notes
1 95th RS will relocate to RAF Fairford in 2023.
2 Active associate squadron shares aircraft assigned to the Air National Guard's co-located 117th ARW.
3 Squadron utilises aircraft assigned to host wing.
4 645th AESG is based at Wright-Patterson Air Force Base, Ohio.
5 Active associate squadron shares aircraft assigned to the Air National Guard's co-located 126th ARW.
6 Active associate squadron shares aircraft assigned to the Air Force Reserve Command's co-located 452nd AMW.
7 Air National Guard Associate unit shares aircraft assigned to the 92nd ARW.
8 Associate squadron operates alongside 55th Wing's 338th CTS.
9 Associate unit shares aircraft assigned to the 22nd ARW.
10 Associate unit supports 97th AMW KC-135 and C-17 training operations.

Training for all of the 55th Wing RC-135 variants is supported by three TC-135Ws.

A pair of OC-135Bs are assigned to support the Defense Threat Reduction Agency's (DTRA) verification mission. The aircraft have supported short-notice, unrestricted aerial observation flights over the territory of any of the 34 Open Skies Treaty signatory nations. In May 2020, the US formally announced its intention to withdraw from the treaty. As a result, plans to replace the two OC-135Bs under the Open Skies Treaty Aircraft Recapitalization (OSTAR) program were formally cancelled in July 2020.

A draft RFP for the OSTAR was issued in February 2019 and contract award had been planned for early 2020. The OSTAR would have 're-hosted' the OC-135B's capability on two small commercial off-the-shelf airliners.

Although planning for a replacement had begun, the OC-135B had been receiving system upgrades in the form of new camera equipment. The OC-135B's optical camera suite includes a single vertical and two oblique KS-87E framing cameras and a single KA-91C panoramic camera. The upgrade, which had been carried out on one of the OC-135Bs, replaced the film cameras with a digital visual imaging system developed by KIHOMAC under a three-year $36.6 million contract awarded in early 2016.

Support for the Constant Phoenix atmospheric collection mission is currently provided by a single WC-135W. The mission ensures the 1963 Limited Nuclear Test Ban Treaty is upheld by collecting air samples in order to detect the presence of radioactive particles. In recent years, the aircraft have also been tasked to investigate fallout from nuclear tests and accidents involving radioactive material.

The Air Force will replace the WC-135W with three former late-model ANG KC-135Rs modified for use as atmospheric collection aircraft with a new mission sensor system. The project is managed by the Big Safari acquisitions group and conversion of the first aircraft began in May 2020 at the L3Harris facility in Greenville, Texas. Delivery should occur by mid-2022 and all three WC-135R conversions will be completed by mid-2024.

The OC-135B and WC-135W are the only Stratolifter variants to retain the original Pratt & Whitney turbofan engines, the TF33-P-9 and TF-33-P-5, respectively.

The C-135 series was upgraded to the Block 40 Pacer-CRAG (Compass, Radar And GPS) and subsequent Global Air Traffic Management programmes that modernised the Communication, Navigation, Surveillance and Air Traffic Management systems. The KC-135 Block 45 upgrade program provides the aircraft with a new digital autopilot, flight director and radar altimeter and electronic engine instrument display. The upgrades are being installed in 399 C-135 series aircraft including two prototype installations that were carried out under the programme's EMD phase. Completed in July 2016, low rate initial production totalled 36 aircraft. Fleet-wide installations of the Rockwell Collins developed upgrades will be completed in 2026. Additional upgrades will provide the fleet with replacements for its current International Marine/Maritime Satellite Aeronautical Intermediate satellite communication system.

C-145A Skytruck

Air Force Special Operations Command (AFSOC) added the PZL M28-05 to its inventory in August 2009. The Skytruck was one of several non-standard aviation platforms acquired by the command in response to the 'global war on terror'. The short take-off and landing M28-05 is a Westernised version of the Antonov An-28. The aircraft were produced by Sikorsky Aircraft's PZL Mielec (Polskie Zaklady Lotnicze) subsidiary in Poland and modified for AFSOC missions by the Sierra Nevada Corporation (SNC).

AFSOC used the light cargo and passenger aircraft to move small groups of special operations personnel to areas with unimproved landing strips. SNC delivered the last of 17 aircraft to the 318th Special Operations Squadron at Cannon Air Force Base, New Mexico, in March 2012. The aircraft received the non-standard military designation C-145A in May 2012.

The C-145A fleet was later transferred from Cannon to Duke Field in Florida and reassigned to the Aviation Foreign Internal Defense or AvFID mission. AFSOC currently operates five C-145As but 11 were placed in storage at Davis-Monthan Air Force Base. Two were subsequently transferred to law enforcement duties with the Arizona Department of Public Safety, before being passed on to civil operators. Two Skytrucks were transferred to Estonia and three will reportedly be passed on to Kenya. The four aircraft that remain in storage at the Tucson base have also been identified for transfer to partner air arms.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
6th SOS	Duke Field, Florida	C-145A	492nd SOW/SOG	AFSOC	
Air Force Reserve Command units					
5th SOS (see Note 1)	Hurlburt Field, Florida	C-145A	919th SOW/SOG	AFSOC	
711th SOS (see Note 2)	Duke Field, Florida	C-145A	919th SOW/SOG	AFSOC	

Notes
1 Associate unit, shares responsibility for aircraft with co-located active-duty squadron, which supports AFSOTC/19th SOS Combat Aviation Advisor (CAA) training efforts.
2 711th SOS operates as an associate squadron and supports the 6th SOS training mission.

ABBREVIATIONS

ANGS	Air National Guard Station	**CTS**	Combat Training Squadron
ARB	Air Reserve Base	**Det**	Detachment
ARG	Air Refueling Group	**DIA**	Defense Intelligence Agency
ARS	Air Refueling Squadron	**DSCA**	Defense Security Cooperation Agency
ARS	Air Reserve Station	**FG**	Fighter Group
ARW	Air Refueling Wing	**FLTF**	Flight Test Flight
AS	Airlift Squadron	**FLTG**	Flight Test Group
ASF	Aviation Standards Flight	**FLTS**	Flight Test Squadron
ATG	Adversary Tactics Group	**FS**	Fighter Squadron
ATKS	Attack Squadron	**FW**	Fighter Wing
ATKW	Attack Wing	**FTG**	Flying Training Group
ATRS	Aerial Targets Squadron	**FTOF**	Flight Test Operations Facility
AW	Airlift Wing	**FTRS**	Fighter Training Squadron
BS	Bomb Squadron	**FTS**	Flying Training Squadron
BW	Bomb Wing	**(FTU)**	Formal Training Unit
CACG	Command and Control Group	**FTW**	Flying Training Wing
CCW	Command & Control Wing	**HQ**	Headquarters

C-146A Wolfhound

AFSOC acquired 20 Dornier Do328-110 commuter airliners that are operated under the non-standard designation C-146A. Assigned the popular name 'Wolfhound', the aircraft primarily provide airlift support for small teams of special operations personnel assigned to Theater Special Operations Commands.

Acquisition of the 'Wolfhounds' began in FY2010 and the Sierra Nevada Corporation delivered the initial pair of Do328s in October 2011. The non-standard military designation C-146A was assigned in May 2012. The aircraft were consolidated at Duke Field in Florida in 2017, where they are operated by active component and Air Force Reserve Command AFSOC units.

Air Force Materiel Command operates a single Do328 'Cougar' as a development platform for ISR payloads, weapons, survivability, and communications equipment.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
524th SOS	Duke Field, Florida	C-146A	492nd SOW/SOG	AFSOC	
	Wright-Patterson Air Force Base, Ohio	Do328-100	645th AESG	AFMC	
Air Force Reserve Command units					
859th SOS	Hurlburt Field, Florida	C-146A	919th SOW/SOG	AFSOC	

E-3B, E-3BC, E-3G Sentry

Production E-3A Sentry aircraft deliveries to the 552nd Airborne Warning and Control Wing at Tinker Air Force Base, Oklahoma, began in March 1977. Beginning with the 26th E-3A, the upgraded APY-2 radar provided improved maritime capabilities. APY-1 and APY-2 equipped E-3As were respectively re-designated as the E-3B and E-3C. The APY-1 or APY-2 long-range surveillance radar features a 30ft rotating radar antenna that allows location of low-flying targets at a range of more than 200 miles.

The Block 30/35 upgrade provided the Sentry with a passive sensor capability, when the AYR-1 electronic support measures (ESM) system was installed. Additional upgrades provided a GPS navigation capability, upgraded secure datalink communications and an upgraded central computer. The radar computer, operator consoles, selected system hardware, and radar sub-system software were upgraded and replaced under the radar system improvement program (RSIP).

The most recent modernisation projects are upgrading the battle management mission systems, combat identification and the cockpit avionics suite. The aircraft are currently being equipped with an open-architecture, commercial off-the-shelf hardware that includes new mission computing hardware and software, mission consoles, and upgraded ESM equipment. The $2.7 billion Block 40/45 upgrade program is the largest in the Sentry's history. Assigned the designation E-3G, the first updated Sentry was rolled out in August 2011 and the new variant achieved initial operational capability in July 2014. At the end of FY2020, 23 Sentries had been upgraded to E-3G configuration and seven E-3Bs and a single E-3C remained on the inventory. The E-3G will likely achieve full operational capability by May 2024 when the conversion of 31 aircraft is completed.

As part of another upgrade program dubbed the Diminishing manufacturing sources Replacement of Avionics for Global Operations and Navigation (DRAGON), the E-3's analogue cockpit instruments are being replaced by five modern digital full-colour 'glass' displays. The 552nd Air Control Wing received the first DRAGON E-3G in January 2017. Modifications are being carried out at Tinker Air Force Base.

The Internet Protocol Enabled Communications programme is providing a satellite-based, internet protocol enabled communications package that operates over high bandwidth classified and multi-domain networks. The system provides the E-3G with connectivity that enables simultaneous chat, air tasking order, airspace control order, e-mail with attachments, and website download capability.

The E-3 Communication Network Upgrade will provide a Link 16 capability with high-jam-resistance, high-speed, crypto-secure computer-to-computer connectivity. It will also permit the E-3 to receive and transmit fifth-generation fighter platform sensor data. The modification is intended to keep the E-3G viable through to 2038.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
960th AACS	Tinker Air Force Base, Oklahoma	E-3B, E-3G	552nd ACW/OG	ACC	OK
961st AACS	Kadena Air Base Okinawa	E-3B	18th Wing/OG	PACAF	ZZ
962nd AACS	Joint Base Elmendorf-Richardson, Alaska	E-3B, E-3C	3rd Wing/OG	PACAF	AK
963rd AACS	Tinker Air Force Base, Oklahoma	E-3G	552nd ACW/OG	ACC	OK
964th AACS	Tinker Air Force Base, Oklahoma	E-3G	552nd ACW/OG	ACC	OK
965th AACS	Tinker Air Force Base, Oklahoma	E-3G	552nd ACW/OG	ACC	OK
966th AACS (FTU)	Tinker Air Force Base, Oklahoma	E-3G	552nd ACW/OG	ACC	OK
Det 1, 605th TES (See Note 1, 2)	Tinker Air Force Base, Oklahoma	E-3B, E-3C, E-3G	505th CCW/TEG	ACC	OK
96th OG Det. 2 (see Note 2)	Tinker Air Force Base, Oklahoma	E-3B, E-3C, E-3G	96th TW/OG	AFMC	OK
Air Force Reserve Command units					
970th AACS (see Note 2)	Tinker Air Force Base, Oklahoma	E-3G	513th ACG	ACC	OK

Notes

1 605th TES and 505th CCW are located at Hurlburt Field, Florida. 505th TEG is located at Nellis Air Force Base, Nevada and conducts Operational Test of ISR weapons systems.

2 Unit operates E-3B/C/G as an associate to the 552nd ACW.

E-4B 'Nightwatch'

The Air Force operates four modified Boeing 747-200Bs under the designation E-4B. Originally delivered to Strategic Air Command in December 1974 under the designation E-4A, the aircraft were later upgraded and the first E-4B entered service in January 1980. The upgrades were completed in January 1985.

The E-4Bs are normally based at Offutt Air Force Base, Nebraska and are assigned to Air Force Global Strike Command's 1st Airborne Air Control Squadron. An E-4B and its 63-person crew stand a 24-hour ground alert.

E-4Bs are tasked as the National Airborne Operations Center (NAOC) for the National Command Authorities. The NAOC provides services as a survivable, and enduring communications node of the National Military Command System in support of civilian and military leadership. The E-4Bs are capable of executing emergency war orders and would serve as a survivable, command, control, and communications centre in the event of a national emergency or if ground command control centres were destroyed.

The aircraft has a maximum crew size of 114 comprising a joint-service operations team, a flight crew, maintenance and security component, and communications team.

A number of ongoing upgrades are providing the E-4Bs with updated systems. The Survivable Super High Frequency system provides voice/data capability in operational environments where electronic jamming is present while addressing reliability and maintainability issues with the aircraft's Jam-Resistant Secure Communications system. Additionally, the Low Frequency Transmit System will replace the aircraft's current Very Low Frequency/Low Frequency capability. It replaces the existing dual trailing wire antenna and reduces aircraft weight by almost a ton.

Furthermore, the Family of Beyond-Line-Of-Sight Terminals (FAir Base-T) / Presidential National Voice Conferencing system will replace the Military Strategic Tactical Relay (MILSTAR) / Survivable Emergency Conferencing Network systems.

Boeing has determined that the design service life of the E-4B airframe is 115,000 flight hours and 30,000 take-off/landing cycles. Based on current utilisation, the aircraft are expected to reach that limit by 2033. The Air Force is already moving forward with a programme to recapitalise the E-4Bs. The Survivable Airborne Operations Center weapon system that will replace the legacy E-4B will be built on a commercial derivative aircraft. The platform will feature new mission systems, including a modern communications subsystem, networks and advanced command and control subsystems.

Meanwhile, the service is completing a study that is looking at the possibility of acquiring a commercial aircraft that could replace the NAOC as well as four C-32As and 16 E-6Bs operated by the US Air Force and the US Navy.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
1st ACCS	Offutt Air Force Base, Nebraska	E-4B	595th CACG	ACC	

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
12th ACCS (see Note 1)	Robins Air Force Base, Georgia	E-8C	461st ACW/ OG	ACC	GA
16th ACCS (see Note 1)	Robins Air Force Base, Georgia	E-8C	461st ACW/ OG	ACC	GA
330th CTS (FTU) (see Note 1)	Robins Air Force Base, Georgia	TE-8A, E-8C	461st ACW/ OG	ACC	GA
Det 2, 605th TES (See Note 2)	Melbourne International Airport, Florida	E-8C	505th CCW/ TEG	ACC	
Air National Guard unitst					
128th ACCS	Robins Air Force Base, Georgia	E-8C	116th ACW/ OG	ACC	GA

Notes
1 Active associate squadron utilises aircraft assigned to the Georgia Air National Guard's 116th ACW.
2 605th TES are located at Hurlburt Field, Florida. 505th TEG is located at Nellis Air Force Base, Nevada and conducts Operational Test of ISR weapons systems.

E-8C Joint STARS

Air Combat Command operates 16 heavily modified Boeing 707-300 aircraft under the designation E-8C from Robins Air Force Base, Georgia. Although assigned to the Georgia Air National Guard's 116th Air Control Wing (ACW), the responsibility for operations and maintenance is shared with the 461st ACW, which maintains an active associate relationship with the ANG unit.

Known as Joint Surveillance and Target Acquisition Radar System — Joint STARS (JSTARS) — aircraft the E-8Cs serve as airborne battle management command and control platforms. The APY-7 radar can detect targets at ranges from 31 to 155 miles. The system's synthetic aperture radar and ground moving target indicator modes provide long-endurance, all-weather, surveillance and targeting of moving and stationary targets. The E-8C is flown by a crew of four and its mission crew typically includes 15 Air Force and three US Army specialists.

Development of JSTARS began in September 1985 and Grumman Aerospace produced two E-8A test aircraft. The E-8A version first flew in December 1988 and while still under development both prototypes were deployed to support Operation Desert Storm in 1991. A single development JE-8C aircraft and 17-production E-8Cs followed. The first operational E-8C arrived at Robins in June 1996 and the final example arrived in April 2005. Since entering service, one E-8C has been written off following a ground fire that heavily damaged the airframe. The developmental JE-8C has also been retired and a single TE-8A supports training at Robins.

A JSTARS recap program that was initiated in January 2014 was cancelled in 2018. As an alternative, the Air Force is developing the Advanced Battle Management System (ABMS) that will link together currently fielded and newly developed aircraft and space-based sensors. The systems will be connected via newly developed communications links to support battlespace management. Restrictions placed on the service will ensure that the E-8C fleet is retained until Increment 2 of the ABMS is declared operational.

E-8C JSTARS 94-0284 from the 116th Air Control Wing, Robins Air Force Base, Georgia. US Air Force/Greg Davis

ABBREVIATIONS

HG	Helicopter Group	**RW**	Reconnaissance Wing
HS	Helicopter Squadron	**SOG**	Special Operations Group
IFS	Introductory Flight Screening	**SOS**	Special Operations Squadron
JB	Joint Base	**SOW**	Special Operations Wing
JNGS	Joint National Guard Station	**TEG**	Test and Evaluation Group
JRB	Joint Reserve Base	**TES**	Test and Evaluation Squadron
NAF	Naval Air Facility	**TESTG**	Test Group
NAS	Naval Air Station	**TPS**	Test Pilot School
NSA	Naval Support Activity	**TRS**	Training Squadron
OG	Operations Group	**TW**	Test Wing
OS	Operations Squadron	**USAF**	United States Air Force
PACAF	Pacific Air Forces	**USAFA**	United States Air Force Academy
PAG	Presidential Airlift Group	**USAFE**	United States Air Forces Europe
PAS	Presidential Airlift Squadron	**USAFWC**	US Air Force Weapons Center
RAF	Royal Air Force	**USAFWS**	US Air Force Weapons School
RG	Reconnaissance Group	**USCENTOM**	US Central Command
RQG	Rescue Group	**USSOUTHCOM**	US Southern Command
RQS	Rescue Squadron	**WEG**	Weapons Evaluation Group
RQW	Rescue Wing	**WPS**	Weapons Squadron
RS	Reconnaissance Squadron	**WRS**	Weather Reconnaissance Squadron
RSO	Remote Split Operations		

E-9A 'Widget'

The 82nd Aerial Targets Squadron operates two modified de Havilland Canada DHC-8s as range support aircraft from Tyndall Air Force Base, Florida, under the designation E-9A. Known as 'Widgets', the E-9As were modified by Sierra Research and entered service in 1988. The Dash 8s are equipped with an APS-143(V)1 airborne sea surveillance radar that is used for range surveillance and safety. A large, phased array antenna permits the E-9A to simultaneously receive, record and downlink telemetry from aircraft missiles and other sources. The Widgets are also equipped with an over-the-horizon ultra-high frequency command, initiate and destruct relay system that permits them to destroy target drones and weapons should the need arise.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
82nd ATRS	Tyndall Air Force Base, Florida	E-9A	53rd Wing/53rd WEG	ACC	TD

E-11A

The Air Force's Battlefield Airborne Communications Node (BACN) was developed by Northrop Grumman to support operations over the rugged terrain of Afghanistan. It provides the capability to conduct voice bridging/translation, Tactical Data Link (TDL) gateway, and TDL relay functions for beyond-line-of-sight communications over long distances. The system was first flown in August 2007 aboard Bombardier BD700 Global Express test aircraft N901GX.

The BACN was subsequently integrated on two Global Express XRS aircraft that were deployed to Afghanistan in late 2008. Originally leased from Northrop Grumman, the three aircraft were purchased by the Air Force in 2011 and the designation E-11A was assigned. A fourth E-11A was delivered in late-2013, when Northrop Grumman integrated the system on a Global 6000.

The system is currently installed on three manned E-11A aircraft and four unmanned Block 20 EQ-4B remotely piloted aircraft. A fourth E-11A was written off in a mishap that occurred in eastern Afghanistan's Ghazni province, on January 27, 2020.

The E-11As are forward deployed and are operated by the 451st Air Expeditionary Group's 430th Expeditionary Electronic Combat Squadron, from Kandahar Airfield, Afghanistan. The Air Force recently announced plans to retire the EQ-4Bs but plans to expand the E-11A fleet beginning in FY2021 when the first of five aircraft is purchased. Plans include the acquisition of one additional E-11A annually through FY2025.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
430th EECS	Kandahar Airport, Afghanistan	E-11A	451st EOG/ AEG	ACC	

F-15C, F-15D Eagle, F-15E Strike Eagle

Considered a fourth-generation fighter, the F-15 first flew in prototype form in July 1972 and despite having served the US Air Force for 48 years, the Eagle remains an important component of the Air Force fleet. In July 2020, the service placed an order for eight F-15EX models that marked its first Eagle purchase since 2001.

The first F-15As entered service in November 1974 at Luke Air Force Base, Arizona and fielding of the F-15C and F-15D followed beginning in 1979. The Air Force had planned to retain a limited number of F-15C and F-15Ds in service until around 2045. In support of that plan 93 active component and 112 Air National Guard-assigned Eagles are being equipped with Raytheon APG-63(V)3 active electronically scanned array (AESA) radar. To date, 197 upgrades have been funded. Additionally, the F-15C's current mission computer is being replaced by the Advanced Display Core Processor II, which is common with the newer F-15E. The modification, which will be carried out on 37 active component and 107 Air National Guard-assigned Eagles, also installs a new high-resolution colour display and a remote interface unit in place of the fighter's current 5x5-in vertical situation display. Lockheed Martin's Legion Pod Infrared Search and Track (IRST) system is also being integrated with the F-15C. Integration of the multi-function sensor pod will provide Eagle pilots with a passive capability to detect and track aerial targets via their thermal signature. The Air Force fleet currently includes 88 F-15Cs and nine F-15Ds that are flown by active component squadrons and 123 F-15Cs and 14 F-15Ds with Air National Guard squadrons.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
17th WPS	Nellis Air Force Base, Nevada	F-15E	57th Wing/US Air Force Weapon School	ACC	WA
40th FLTS	Eglin Air Force Base, Florida	F-15C, F-15D, F-15E	96th TW/OG	AFMC	ET
44th FS	Kadena Air Base, Okinawa	F-15C, F-15D	18th Wing/OG	PACAF	ZZ
67th FS	Kadena Air Base, Okinawa	F-15C, F-15D	18th Wing/OG	PACAF	ZZ
85th TES	Eglin Air Force Base, Florida	F-15C, F-15E	53rd Wing/53rd TEG	ACC	OT
333rd FS (FTU)	Seymour Johnson Air Force Base, North Carolina	F-15E	4th FW/OG	ACC	SJ
334th FS (FTU)	Seymour Johnson Air Force Base, North Carolina	F-15E	4th FW/OG	ACC	SJ
335th FS	Seymour Johnson Air Force Base, North Carolina	F-15E	4th FW/OG	ACC	SJ
336th FS	Seymour Johnson Air Force Base, North Carolina	F-15E	4th FW/OG	ACC	SJ
389th FS	Mountain Home Air Force Base, Idaho	F-15E	366th FW/OG	ACC	MO
391st FS	Mountain Home Air Force Base, Idaho	F-15E	366th FW/OG	ACC	MO
422nd TES	Nellis Air Force Base, Nevada	F-15C, F-15D, F-15E	53rd Wing/53rd TEG	ACC	OT
428th FS see Note 1)	Mountain Home Air Force Base, Idaho	F-15SG	366th FW/OG	ACC	MO
433rd WPS (see Note 2)	Nellis Air Force Base, Nevada	F-15C, F-15D	57th Wing/US Air Force Weapon School	ACC	WA
492nd FS	RAF Lakenheath, Suffolk, England	F-15E	48th FW/OG	USAFE	LN
493rd FS	RAF Lakenheath, Suffolk, England	F-15C, F-15D	48th FW/OG	USAFE	LN
494th FS	RAF Lakenheath, Suffolk, England	F-15E	48th FW/OG	USAFE	LN
550th FS (see Note 3)	Klamath Falls Airport-Kingsley Field, Oregon	F-15C, F-15D	56th FW/OG	AETC	
Air National Guard units					
114th FS (see Note 4)	Klamath Falls Airport-Kingsley Field, Oregon	F-15C, F-15D	173rd FW/OG	AETC	
122nd FS	NAS JRB New Orleans, Louisiana	F-15C, F-15D	159th FW/OG	ACC	JZ
123rd FS (see Note 5)	Portland International Airport/Air National Guard Base, Oregon	F-15C, F-15D	142nd Wing/OG	ACC	
131st FS	Westfield Barnes Airport/ Air National Guard Base, Massachusetts	F-15C, F-15D	104th FW/OG	ACC	MA
159th FS	Jacksonville International Airport, Florida	F-15C, F-15D	125th FW/OG	ACC	
194th FS	Fresno-Yosemite International Airport/ Air National Guard Base, California	F-15C, F-15D	144th FW/OG	ACC	
Air Force Reserve Command units					
84 TES (see Note 6)	Eglin Air Force Base, Florida	F-15C, F-15E	926th Wing/OG	ACC	OT
307th FS (see Note 6)	Seymour Johnson Air Force Base, North Carolina	F-15E	944th FW/414th FG	ACC	SJ
706th FS (see Note 6)	Nellis Air Force Base, Nevada	F-15C, F-15D, F-15E	926th Wing/OG	ACC	WA

Notes
1 428th FS trains Singapore AF pilots.
2 Squadron utilises aircraft assigned to host wing.
3 Active associate squadron utilises aircraft assigned to the Oregon Air National Guard's 173rd FW.
4 114th FS will become the FTU for the F-15EX
5 123rd FS will transition to the F-15EX
6 Classic associate squadron utilises aircraft assigned to host wing.

An F-15E Strike Eagle assigned to the 492nd Fighter Squadron takes-off from Royal Air Force Lakenheath, England. US Air Force/TSgt Matthew Plew

The Air Force's fleet of 218 multi-role F-15E Strike Eagles is receiving a series of upgrades that include the Raytheon APG-82(V)1 AESA radar. The radar upgrade program will be completed in 2024. The aircraft's ability to survive in high-threat environments will be improved greatly through the installation of the Eagle Passive Active Warning Survivability System (EPAWSS). The system will ensure the Strike Eagle can counter current and future air-to-air and ground-to-air and infrared threats. Additionally, the integration of the ADCP II will permit the full capabilities offered by the APG-82 and EPAWSS to be exploited. The F-15E was formally cleared to deliver the 250lb GBU-53/B Small Diameter Bomb II. Known as the StormBreaker, the weapon is equipped with a tri-mode seeker that permits it to attack stationary or moving targets in any weather. Its three guidance modes comprise infrared, laser, and millimetre wave radar.

The service's 234 F-15C and F-15Ds will begin reaching the end of their design service life around 2024, but Air Force analysis concluded that a service-life extension for the aircraft was not cost effective. As a result, the service has decided to replace a portion of the fleet with new F-15EX fighters. Under the FYDP that runs through 2025, the service will purchase 76 F-15EXs but it could ultimately acquire up to 144 examples. Funding for the first eight fighters, including a pair of prototypes, was provided in the FY2020 NDAA. The Air Force's request for FY2021 included funds for an additional 12 examples. Based on the F-15QA that Boeing developed for the Qatar Emiri Air Force, the two-seat F-15EX's updated avionics will include large-format displays, the APG-82(V)1 AESA radar and EPAWSS. The fighters will feature fly-by-wire flight controls and two additional weapon stations. The initial batch of jets will be powered by GE Aviation F110-GE-129 turbofans, although the Air Force plans to hold an open competition that would allow Pratt & Whitney to offer its F100-PW-229. The new model may also be equipped with the Advanced Missile and Bomb Ejection Rack that will enable it to carry up to 20 long-range AIM-120Ds or a mix of air-to-air and air-ground weapons, including eight AIM-120s and 28 Small Diameter Bombs , or eight AIM-120s and up to seven 2,000lb stores. The Air Force estimates that refreshing the F-15C, F-15D fleet with F-15EXs will save the service $3 billion in transition and construction costs over the FYDP compared to replacing the fleet with F-35A. It determined that it would take around six months or less for an F-15C squadron to

transition to the F-15EX due to the significant commonality between the two variants. By comparison, the transition time from F-15 or F-16 to the F-35 requires around 18 months for active component squadrons and 36 months for Air National Guard units.

The first two aircraft will be delivered to Eglin Air Force Base, Florida in early 2021 and will initially support test and evaluation efforts. The remaining six jets from the first batch will follow in FY2023. The F-15EX will achieve IOC when eight aircraft are in service and FOC will be reached when 44 have been delivered.

Operationally, F-15EX fighters will initially be assigned to two Oregon Air National Guard wings starting with the 173rd Fighter Wing at Kingsley Field in 2022. Fielding to the formal training unit will be followed by the 142nd Fighter Wing at Portland International Airport/Air National Guard Base in 2023.

The Air Force will replace F-15Cs operated by the Air National Guard's 104th, 144th, and 159th Fighter Wings in Massachusetts, California, and Louisiana respectively, with either F-35As or F-15EXs. The service may also be considering replacing some or all of its nearly 220 F-15Es with the new multi-role variant.

F-16C 89-2048/WA assigned to the Nellis-based 64th Aggressor Squadron painted in the 'Wraith' all-black aggressor colour scheme. US Air Force/Airman 1st Class Bryan Guthrie

F-16C, F-16D Fighting Falcon

Although the Air Force accepted the last of 2,231 F-16s from Lockheed Martin in 2005, the Fighting Falcon continues to be an important asset. It is the Air Force's primary multi-role fighter, making up around 50% of the service's fleet. The current inventory includes 781 F-16Cs and 155 F-16Ds. The majority of the fleet is still operated by active-duty squadrons, but the Air National Guard (ANG) has 288 F-16Cs and 45 F-16Ds on its books. Another 52 single-seat and two dual-seat models are operated by the Air Force Reserve Command.

Later variants comprised the Block 30/32, Block 40/42 and Block 50/52. Whereas the Block 30/40 were equipped with General Electric F110-GE-100 turbofans, the Block 32/42 featured F100-PW-220 engines. Later Block 50/52 fighters were powered by the F110-GE-129 and F100-PW-229 Improved Performance Engines (IPE). Block 40/42 F-16Cs were the first to be compatible with the AAQ-13 LANTIRN navigation and AAQ-14 targeting pods. The Block 50/52 models were the first to integrate the AGM-88 HARM and the ASQ-213 HARM Targeting System that supported the 'Wild Weasel' Suppression of Enemy Air Defences mission. General Dynamics sold its Fort Worth division, which included the F-16 programme to Lockheed Martin in 1993.

The Common Configuration Implementation Program was incorporated on more than 200 Block 50/52 and 420 Block 40/42 aircraft between 2002 and 2011. It provided enhanced mission capabilities and integrated a common avionics configuration. It integrated a new modular mission computer, colour displays, common missile warning systems, advanced datalink IFF systems and the Joint Helmet-Mounted Cueing System.

The Air Force refers to its F-16s as pre-Block (Block 25/30/32) and post-Block (Block 40/42 and 50/52). The earlier pre-block variants have a service life of 10,800 equivalent flight hours (EFH). Continuing modernisation projects include a service-life extension programme (SLEP) that extends the airframe's structural service life of the post-Block models from 8,000 to around 12,000 EFH and will allow them to remain in service until the 2045-2048-timeframe. A Block 50 F-16C assigned to the 35th Fighter Wing at Misawa Air Base, Japan, was the first to exceed 10,000 hours in June 2019. Each SLEP requires around nine months to accomplish at a cost of $2.4 million. Under current plans the SLEP will be carried out on around 350 jets by 2029 but it could potentially modify, repair, or replace life-limited components on more than 800 Vipers.

Air National Guard F-16Cs make up 56% of the nation's aerospace control alert fighter force. In January 2020, the Air Force began replacing the APG-68 mechanically scanned radar on 72 ANG F-16Cs that support the air defence mission with the Northrop Grumman APG-83 Scalable Agile Beam Radar (SABR). The contractor is initially producing 72 systems under a $244-million contract issued in 2017. The upgrade was developed in response to a US Northern Command Joint Emergent Operational Need for homeland defence. The radar offers an increase in detection range out to 65nm.

In December 2019, the Air Force revealed plans to expand the APG-83 retrofit program to include up to 372 F-16s with the SABR by 2027. Installation of the radar in F-16Cs assigned to the District of Columbia Air National Guard's 113th Wing began in January 2020. At the time of the full operational capability (FOC) declaration, F-16Cs assigned to the 113th as well as the South Carolina and New Jersey ANG's 169th and 177th Fighter Wings had completed fielding of the radar. Installation on fighters assigned to the South Dakota ANG's 114th Fighter Wing began in September 2020.

In July 2020, the 40th Flight Test Squadron and the 85th Test and Evaluation Squadron conducted the first four-ship formation flight with APG-83-equipped F-16Cs at Eglin Air Force Base, Florida. The flight investigated how the radar would perform in combat and whether there was any radar interference, improved or degraded performance of the individual aircraft's radar signals within the formation.

The APG-83-equipped F-16C reached FOC with the AESA radar during October 2020. The declaration came around a month after the updated Vipers participated in the Guardian Shield 20-02, live-fly cruise missile defence exercise, which was conducted from several

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
Det 1, 56th OG	Tucson International Airport, Arizona	F-16C, F-16D	56th FW/OG	AETC	AZ
AATC	Tucson International Airport, Arizona	F-16C, F-16D (Block 32)	57th Wing/USAFWS	ACC	AT
US Air Force ADS	Nellis Air Force Base, Nevada	F-16C, F-16D (Block 52)	57th Wing	ACC	
US Air Force TPS	Edwards Air Force Base, California	NF-16D	412th TW/OG	AFMC	
8th FS	Holloman Air Force Base, New Mexico	F-16C, F-16D (Block 40)	49th Wing/54th FG	AETC	HO
13th FS	Misawa Air Base, Japan	F-16C, F-16D (Block 50)	35th FW/OG	PACAF	WW
14th FS	Misawa Air Base, Japan	F-16C, F-16D (Block 50)	35th FW/OG	PACAF	WW
16th WPS	Nellis Air Force Base, Nevada	F-16C (Block 42/52), F-16D (Block 52)	57th Wing/US Air Force Weapon School	ACC	WA
18th AGRS	Eielson Air Force Base, Alaska	F-16C, F-16D (Block 30)	354th FW/OG	PACAF	AK
21st FS (see Note 1)	Luke Air Force Base, Arizona	F-16A/B (Block 20)	56th FW/OG	AETC	LF
24th TASS	Nellis Air Force Base, Nevada	F-16C, F-16D (Block 42)	57th Wing/OG	ACC	WA
24th FS (see Note 2)	NAS JRB Fort Worth, Texas	F-16C (Block 30)	20th FW/495th FG	ACC	TX
35th FS	Kunsan Air Base, Republic of Korea	F-16C, F-16D (Block 40)	8th FW/OG	PACAF	WP
36th FS	Osan Air Base, Republic of Korea	F-16C, F-16D (Block 50)	51st FW/OG	PACAF	OS
40th FLTS	Eglin Air Force Base, Florida	F-16C (Block 25/40/42/50), F-16D (Block 40/50	96th TW/OG	AFMC	ET
55th FS	Shaw Air Force Base, South Carolina	F-16C, F-16D (Block 50)	20th FW/OG	ACC	SW
64th AGRS	Nellis Air Force Base, Nevada	F-16C, F-16D (Block 25/32/42)	57th Wing/OG	ACC	WA
77th FS	Shaw Air Force Base, South Carolina	F-16C, F-16D (Block 50)	20th FW/OG	ACC	SW
79th FS	Shaw Air Force Base, South Carolina	F-16C, F-16D (Block 50)	20th FW/OG	ACC	SW
80th FS	Kunsan Air Base, Republic of Korea	F-16C, F-16D (Block 40)	8th FW/OG	PACAF	WP
82nd ATRS	Tyndall Air Force Base, Florida	QF-16A/C	53rd Wing/53rd WEG	ACC	TD
82nd ATRS Det. 1	Holloman Air Force Base, New Mexico	QF-16A/C	53rd Wing/53rd WEG	ACC	
85th TES	Eglin Air Force Base, Florida	F-16C, F-16D (Block 40/50), QF-16C	53rd Wing/53rd TEG	ACC	OT
309th FS	Luke Air Force Base, Arizona	F-16C, F-16D (Block 25)	56th FW/OG	AETC	LF
310th FS	Luke Air Force Base, Arizona	F-16C, F-16D (Block 42)	56th FW/OG	AETC	LF
311th FS	Holloman Air Force Base, New Mexico	F-16C, F-16D (Block 42)	49th Wing/54th FG	AETC	HO
314th FS	Holloman Air Force Base, New Mexico	F-16C, F-16D (Block 42)	49th Wing/54th FG	AETC	HO
315th FS (see Note 2)	Burlington International Airport, Vermont	F-16C (Block 30)	20th FW/495th FG	ACC	
316th FS (see Note 2)	McEntire JNGB, Eastover, South Carolina	F-16C (Block 52)	20th FW/495th FG	ACC	
355th FS (see Note 2)	NAS JRB Fort Worth, Texas	F-16C (Block 30)	20th FW/495th FG	ACC	TX
367th FS (see Note 2)	Homestead ARB, Florida	F-16C (Block 30)	20th FW/495th FG	ACC	FM
377th FS (see Note 2)	Montgomery Regional Airport-Dannelly Field, Alabama	F-16C (Block 30)	20th FW/495th FG	ACC	AL
378th FS (see Note 2)	Dane County Regional Airport-Truax Field, Madison, Wisconsin	F-16C (Block 30)	20th FW/495th FG	ACC	WI
416th FLTS	Edwards Air Force Base, California	F-16C, F-16D (Block 30/40/42/50)	412th TW/OG	AFMC	ED
422nd TES	Nellis Air Force Base, Nevada	F-16C, F-16D (Block 42/52)	53rd Wing/53rd TEG	ACC	OT
425th FS (see Note 3)	Luke Air Force Base, Arizona	F-16C, F-16D (Block 42)	56th FW/OG	AETC	LF
480th FS	Spangdahlem Air Base, Germany	F-16C, F-16D (Block 50)	52nd FW/OG	US Air Force	SP
510th FS	Aviano Air Base, Italy	F-16C, F-16D (Block 40)	31st FW/OG	US Air Force	AV
555th FS	Aviano Air Base, Italy	F-16C, F-16D (Block 40)	31st FW/OG	US Air Force	AV
Air National Guard units					
AATC	Morris Air National Guard Base/Tucson International Airport, Arizona	F-16C, F-16D (Block 32/42/52)	USAFWS	ACC	AT
100th FS	Montgomery Regional Airport-Dannelly Field, Alabama	F-16C, F-16D (Block 30)	187th FW/OG	ACC	AL
112th FS	Toledo Express Airport, Swanton, Ohio	F-16C, F-16D (Block 42)	180th FW/OG	ACC	OH
119th FS	Atlantic City International Airport/ Air National Guard Base, New Jersey	F-16C (Block 30)	177th FW/OG	ACC	NJ
120th FS	Buckley Air Force Base, Aurora, Colorado	F-16C (Block 30)	140th FW/OG	ACC	CO
121st FS	Joint Base Andrews-NAF Washington, Maryland	F-16C, F-16D (Block 30)	113th Wing/OG	ACC	DC
125th FS	Tulsa International Airport, Oklahoma	F-16C, F-16D (Block 42)	138th FW/OG	ACC	OK
148th FS (FTU) (see Note 4)	Morris Air National Guard Base/Tucson International Airport, Arizona	F-16A/B (MLU)	162nd Wing/OG	AETC	AZ
152nd FS (FTU)	Morris Air National Guard Base/Tucson International Airport, Arizona	F-16C, F-16D (Block 42)	162nd Wing/OG	AETC	AZ
157th FS	McEntire JNGB, Eastover, South Carolina	F-16C, F-16D (Block 52)	169th FW/OG	ACC	
175th FS	Sioux Falls Regional Airport-Joe Foss Field, South Dakota	F-16C, F-16D (Block 40)	114th FW/OG	ACC	
176th FS	Dane County Regional Airport-Truax Field, Madison, Wisconsin	F-16C (Block 30)	115th FW/OG	ACC	WI
179th FS	Duluth International Airport/Air National Guard Base, Minnesota	F-16C (Block 50)	148th FW/OG	ACC	MN
182nd FS (FTU)	Joint Base San Antonio-Kelly Field, Lackland Air Force Base, Texas	F-16C, F-16D (Block 30)	149th FW/OG	AETC	SA
195th FS (FTU)	Morris Air National Guard Base/Tucson International Airport, Arizona	F-16C, F-16D (Block 25/32)	162nd Wing/OG	AETC	AZ
Air Force Reserve Command units					
69th FS (see Note 5)	Luke Air Force Base, Arizona	F-16C, F-16D (Block 25/42)	944th FW/OG	AETC	LF
84 TES (see Note 6)	Eglin Air Force Base, Florida	F-16C, F-16D (Block 40/50),	926th Wing/OG	ACC	OT
93rd FS	Homestead ARB, Florida	F-16C, F-16D (Block 30)	482nd FW/OG		FM
457th FS	NAS JRB Fort Worth/ Carswell Field, Texas	F-16C, F-16D (Block 30)	301st FW/OG	ACC	TX
466th FS (see Note 5)	Hill Air Force Base, Utah	F-16C, F-16D (Block 40)	419th FW/OG		HL
706th FS (see Note 6)	Nellis Air Force Base, Nevada	F-16C, F-16D	926th Wing/OG		WA

Notes
1 21st FS trains Republic of China Air Force pilots and will relocate to Morris Air National Guard Base/ Tucson International Airport, Arizona, in 2021.
2 Active associate unit.
3 425th FS trains Republic of Singapore Air Force pilots.
4 148th FS trains Royal Netherlands Air Force pilots using Dutch-owned aircraft.
5 AETC gained associate unit operates F-16C, F-16D in support of 56th FW.
6 Classic associate squadron utilises aircraft assigned to host wing.

mid-Atlantic facilities and over the Atlantic Test Range.

Integration of the radar is one of 13 upgrades being carried out on the Air Force's F-16 fleet. The projects include integration of the Lockheed Martin automatic ground-collision avoidance system, Raytheon ALR-69A digital radar warning receiver, and the advanced Mode 5 IFF. Jets are also being equipped with a communications suite upgrade that includes the Collins Aerospace ARC-210 satellite radio and updated Link 16 Multifunctional Information Distribution System-Joint Tactical Radio System. Installation of the AGCAS will be completed by FY2025.

Planned weapons upgrades will integrate the B61-12 tactical nuclear weapon and the AGR-20A Advanced Precision Kill Weapon System laser-guided rockets. During a December 2019 proof of concept demonstration an F-16C shot down a subscale drone, simulating a cruise missile with an APKWS rocket.

While upgrading its F-16C fleet, the service continues to modify early F-16s to serve as Full Scale Aerial Targets (FSAT). The Air Force initially contracted Boeing Global Services and Support to modify two Block 15 F-16As, two Block 25 and two Block 30 F-16Cs to QF-16 configuration. Operational and developmental testing began following the arrival of the first QF-16 at Tyndall Air Force Base, Florida, in November 2012. The first production QF-16C was accepted by the 82nd Aerial Targets Squadron at Tyndall on March 11, 2015 and the new FSAT achieved initial operational capability on September 23, 2016. Operations began in February 2017 at Holloman Air Force Base, New Mexico and the first QF-16 live shoot-down occurred in July 2016. Deliveries from a second modification line operated by Boeing and the 309th Aerospace Maintenance and Regeneration Group at Davis-Monthan Air Force Base, Arizona, under a public-private partnership which began in June 2020. The service's plans originally included the conversion of 126 F-16s into targets and more than 100 have already been placed on contract.

The Air Force received funding for 12 QF-16s under the FY2020 National Defense Authorization Act and requested 13 more for conversion in FY2021.

F-22 Raptor

The Raptor was selected as the winner of the US Air Force's Advanced Tactical Fighter competition in April 1991 and Lockheed Martin produced nine engineering and manufacturing development F-22s at its Marietta, Georgia facility.

The F-22's first combat strike was logged by the 94th Expeditionary Fighter Squadron (EFS) when 1,000lb Joint Direct Attack Munitions (JDAM) were delivered on targets in northern Syria on September 22, 2014. Raptors operated by the 95th EFS later carried out the Raptor's first air strikes in Afghanistan on November 19, 2017, when 250lb GBU-39 SDBs were delivered. Although it was developed as an air superiority fighter, the fighter's air-to-ground capability was updated by Increment 2, which provided the capability to deploy AIM-9M and AIM-120C air-to-air missiles and two 1,000lb GBU-32 JDAMs. Additionally, an upgraded Intra-Flight Datalink (IFDL) provided enhanced connectivity with other Raptors.

The subsequent Increment 3.1 upgraded the fighter's APG-77 radar and provided a synthetic aperture ground-mapping mode. It also added improved electronic attack and threat geo-location capabilities and made the fighter capable of delivering up to eight GBU-39/B SDBs.

Software upgrades integrated under Increment 3.2A delivered enhanced electronic protection and improved communications that included a Link 16 datalink receive mode and enhanced combat identification and targeting capabilities. Increment 3.2B, which is currently fielded, improves the IFDL, provides an enhanced stores management system, upgrades emitter geo-location and electronic protection capabilities and adds AIM-9X Block II and AIM-120D. Low rate initial production installations began in 2019 and modifications to 143 Raptors will be completed by the end of FY2021 at a cost of around $1.5 billion. The Air Force has introduced a new software development strategy called Raptor Agile Capability Release (RACR) that will permit it to field new capabilities more rapidly. RACR 1 includes initial Link 16 transmit and Mode 5 IFF transponder capabilities. Fielding will begin in the latter part of FY2021. The communications upgrades include the Multi-Function Information Distribution System-Joint Tactical Radio System which will allow the fighter to meet tactical mandates (TACMAN) and will be fielded to all Block 30/35 F-22s. Ultimately the F-22 fleet will comprise 139 combat-coded Block 30/35s, 31 training Block 20s, 12 Block 20/30/35s and two pre-block test aircraft.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
19th FS (ASSOC)	Joint Base Pearl Harbor-Hickam, Hawaii	F-22A	15th Wing/OG	PACAF	HH
27th FS	Joint Base Langley-Eustis, Virginia	F-22A	1st FW/OG	ACC	FF
31st TES (see Note 1)	Edwards Air Force Base, California	F-22A	53rd Wing/53rd TEG	ACC	ED
43rd FS (FTU) (see Note 2)	Tyndall Air Force Base, Florida	F-22A	325th FW/OG	ACC	TY
90th FS	Joint Base Elmendorf-Richardson, Alaska	F-22A	3rd Wing/OG	PACAF	AK
94th FS	Joint Base Langley-Eustis, Virginia	F-22A	1st FW/OG	ACC	FF
411th FLTS	Edwards Air Force Base, California	F-22A	412th TW/OG	AFMC	ED
422nd TES	Nellis Air Force Base, Nevada	F-22A	53rd Wing/53rd TEG	ACC	OT
433rd WPS (see Note 1)	Nellis Air Force Base, Nevada	F-22A	57th Wing/US Air Force Weapon School	ACC	WA
525th FS	Joint Base Elmendorf-Richardson, Alaska	F-22A	3rd Wing/OG	PACAF	AK
Air National Guard units					
149th FS (see Note 3)	Joint Base Langley-Eustis, Virginia	F-22A	192nd FW/OG	ACC	FF
199th FS	Joint Base Pearl Harbor-Hickam, Hawaii	F-22A	154th Wing/OG	PACAF	HH
Air Force Reserve Command units					
301st FS (see Note 4)	Tyndall Air Force Base, Florida	F-22A	301st FW/44th FG	ACC	TY
302nd FS (see Note 3)	Joint Base Elmendorf-Richardson, Alaska	F-22A	477th FG	PACAF	AK
706th FS (see Note 3)	Nellis Air Force Base, Nevada	F-22A	926th Wing/OG	ACC	WA

Notes
1 Squadron utilises aircraft assigned to host wing.
2 43rd Fighter Squadron is temporarily based at Eglin Air Force Base, Florida.
3 Associate squadron utilises aircraft assigned to host wing.

F-35A Lightning II

The Air Force continues to expand F-35A operations as it fields aircraft to new locations. Since making its first combat deployment to the US Central Command theatre in 2019, the 388th Fighter Wing's three squadrons have supported multiple deployments to the region as well as Europe and the Pacific region. The Air Force plans to field 1,763 F-35As by 2038 as replacements for its F-16C and A-10C fleets. The plans provide 960 combat-coded F-35As that will be assigned to 44 squadrons at 31 operating locations. The Air Force expects to transition more than 20 combat-coded squadrons to the F-35A by 2030.

The F-35A's core missions will include defensive counter-air; close air support; air interdiction; strike, co-ordination, and reconnaissance; non-traditional intelligence, surveillance, and reconnaissance, and suppression/destruction of enemy air defences (SEAD/DEAD).

Low rate initial production deliveries to the 33rd Fighter Wing (FW) at Eglin Air Force Base, Florida, began in July 2011. After a lengthy development period the Block 3i variant of the F-35A achieved initial operating capability (IOC) with Air Combat Command's 34th Fighter Squadron (FS) and Air Force Reserve Command's 466th FS in August 2016. The declaration was preceded by the arrival of the first operational F-35As at Hill Air Force Base, Utah, on September 2, 2015.

The Vermont Air National Guard's 158th FW became the first air guard unit to operate the F-35A when its first pair of Lighting IIs arrived in Burlington in September 2019. The last of the squadron's 20 jets was delivered on October 14, 2020.

Whereas the Block 3i's combat capability was limited to delivering GBU-31 and GBU-32 Joint Direct Attack Munitions, GBU-12 Paveway II laser-guided bombs and AIM-120C AMRAAM missiles from the internal stations, the Block 3F delivered full combat capability. It received fleet release in August 2017 and added AIM-120C7 and AIM-9X air-to-air missiles, 250lb GBU-39 Small Diameter Bombs and AGM-154 Joint Stand-Off Weapons to its inventory. Retrofit of the last of 46 Block 1B and 2B aircraft and 56 Block 3i F-35As from Lots 2-8 to the Block 3F configuration will be completed in 2021.

Under the Capability Development and Delivery programme Lockheed Martin will deliver a series of incremental upgrades for the F-35A. The programme is expected to run through 2026 and cost around $12.1 billion. Block 4 will integrate a new processor and a new electro-optical sensor. Additionally, the Lightning II will become a dual capable aircraft when it is made capable of delivering the B61-12 nuclear weapon. Work on the initial phase of Block 4 started in April 2018.

In June 2020, Lockheed Martin began developing the structural modifications that will improve the F-35A's ability to conduct the SEAD/DEAD mission. The modifications will initially be incorporated on Lot 14 F-35As. The Lightning II's ASQ-239 electronic warfare system can passively detect emissions from an enemy air defence system and geo-locate the targets. The Air Force expects the F-35A will become the main platform for the SEAD/DEAD mission.

F-35As delivered as part of Lot 15 production will feature the Technical Refresh 3 upgrade. It replaces 22 electronic components and integrates the Next-Generation Distributed Aperture System and the L3Harris Integrated Core Processor that will support the planned Block 4 upgrades, which will be retrofitted to 457 F-35As produced in Lots 5-16.

At the end of FY2020 the service had accepted 239 Lightning IIs. Production F-35A deliveries comprised 116 to Air Combat Command, 102 to Air Education and Training Command, two to Air Force Materiel Command and the Air National Guard had received 19. FY2021 fielding plans will see the arrival of F-35As at RAF Lakenheath, England, which will receive two squadrons of Lightning IIs. Recent deliveries saw the first of 54 F-35As arrive at Eielson Air Force Base, Alaska, in April 2020. The resident 354th FW's 356th FS was the first to receive the jets, but it will be followed by the 355th FS. The wing

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
4th FS	Hill Air Force Base, Utah	F-35A	388th FW/ OG	ACC	HL
6th WPS	Nellis Air Force Base, Nevada	F-35A	57th Wing/ USAFWS	ACC	WA
34th FS	Hill Air Force Base, Utah	F-35A	388th FW/ OG	ACC	HL
58th FS	Eglin Air Force Base, Florida	F-35A	33rd FW/OG	AETC	EG
61st FS	Luke Air Force Base, Arizona	F-35A	56th FW/OG	AETC	LF
62nd FS	Luke Air Force Base, Arizona	F-35A	56th FW/OG	AETC	LF
63rd FS	Luke Air Force Base, Arizona	F-35A	56th FW/OG	AETC	LF
308th FS (see Note 1)	Luke Air Force Base, Arizona	F-35A	56th FW/OG	AETC	LF
356th FS (see Note 2)	Eielson Air Force Base, Alaska	F-35A	354th FW/ OG	PACAF	AK
421st FS	Hill Air Force Base, Utah	F-35A	388th FW/ OG	ACC	HL
422nd TES	Nellis Air Force Base, Nevada	F-35A	53rd Wing/53rd TEG	ACC	OT
461st FLTS	Edwards Air Force Base, California	F-35A	412th TW/ OG	AFMC	ED
Air National Guard Units					
134th FS	Burlington International Airport, Vermont	F-35A	158th FW/ OG	ACC	VT
Air Force Reserve Command Units					
69th FS (see Note 3)	Luke Air Force Base, Arizona	F-35A	944th FW/ OG	AETC	LF
466th FS (see Note 4)	Hill Air Force Base, Utah	F-35A	419th FW/ OG	ACC	HL
706th FS (see Note 5)	Nellis Air Force Base, Nevada	F-35A	926th Wing/ OG	ACC	WA

Notes
1 Squadron supports Dutch and Danish training.
2 356th FS was activated on October 10, 2019. First F-35As arrived at Eielson Air Force Base on April 21, 2020.
3 AETC gained associate unit operates F-35A in support of 56th FW.
4 ACC gained associate unit operates F-35A alongside the 388th FW.
5 ACC gained associate unit operates F-35A alongside 422nd TES.

is scheduled to receive 54 F-35As by the end of 2021. At Eglin Air Force Base, the 33rd FW will receive a second training squadron in May 2021 and 24 additional F-35As will begin arriving in October 2021. The new squadron is expected to reach full operational capability by spring 2023. Plans also call for basing a full wing of 72 Lightning IIs at Tyndall Air Force Base, Florida.

Air Force Reserve Command's 301st FW at Naval Air Station Fort Worth Joint Reserve Base, Texas, will become the command's first Lightning II operator with its own fighters. The wing is expected to receive its first Lightning IIs in the mid-2020s. It will be preceded by Wisconsin ANG's 115th FW at Dane County Regional Airport-Truax Field in Madison, and Alabama's 187th FW at Montgomery Regional Airport-Dannelly Field. The two ANG bases expect Lighting II deliveries to begin in 2023. In August 2020, the service announced plans to field F-35As to the Florida ANG's 159th FW at Jacksonville International Airport beginning in 2024.

The Air Force is currently considering five candidate locations for a new international training location for the type intended for foreign military sales customers. The locations include Buckley Air Force Base, Colorado, Ebing Air National Guard Base - Fort Smith Regional Airport, Arkansas, Terre Haute Regional Airport – Hulman Field, Indiana, Joint Base San Antonio-Lackland, Texas, and Selfridge Air National Guard Base, Michigan. The training centre could support as many as 36 F-35As.

F-35A Lightning II 13-5073/OT assigned to the 31st Test Evaluation Squadron based at Edwards Air Force Base, California, launches an AIM-120 AMRAAM missile as part of the aircraft's Block 3F Initial Operational Test and Evaluation. US Air Force/MSgt Michael Jackson

UH-1N, TH-1H Iroquois

The Air Force has operated the Bell Helicopter Model 212 since 1970 when the Twin Huey entered service in the search and rescue (SAR) role under the designation UH-1N.

The service's 63 Twin Hueys are operated by the Air Force Global Strike Command (AFGSC), Air Force Materiel Command (AFMC), Pacific Air Forces (PACAF) and the Air Force District of Washington (AFDW). The AFGSC and the AFDW are the largest operators with 25 and 22 UH-1Ns assigned to the respective commands.

The AFGSC UH-1Ns are tasked to provide airlift for emergency security and disaster response forces, medical evacuation, security surveillance of off-base movements of nuclear weapons convoys and test range areas, airlift of missile support personnel and airborne cable inspections. The Twin Hueys operated by AFDW's 1st Helicopter Squadron conduct high-priority airlift missions and provide a rotary-wing contingency response capability to the National Capital Region.

Ten UH-1Ns assigned to Air Education and Training Command provide survival school support with a secondary SAR mission, when required. PACAF's four UH-1N support airlift requirements in Japan and a pair of Twin Hueys support test and evaluation efforts with AFMC. Three helicopters on the Air Force inventory were previously operated by the US Marine Corps.

In September 2018, the Air Force selected the Leonardo MH-139 to replace the UH-1N. Boeing, which has teamed with Leonardo's AgustaWestland Philadelphia Corporation, will deliver 84 MH-139As.

Air Force rotary wing training is conducted at the US Army Aviation Center of Excellence at Fort Rucker, Alabama. Its training requirements are supported by 28 former US Army UH-1Hs upgraded to TH-1H standard by Bell Helicopter's US Helicopters subsidiary beginning in November 2005.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
1st HS	Joint Base Andrews-Naval Air Facility Washington, Maryland	UH-1N	316th Wing/OG	AFDW	
23rd FTS (see Note 1)	Lowe Army Helicopter Port, Fort Rucker, Alabama	TH-1H	58th SOW/OG	AETC	FR
36th RQS	Fairchild Air Force Base, Washington	UH-1N	58th SOW/OG	AETC	
37th HS	F. E. Warren Air Force Base, Wyoming	UH-1N	582nd HG	AFGSC	FE
40th HS	Malmstrom Air Force Base, Montana	UH-1N	582nd HG	AFGSC	MM
54th HS	Minot Air Force Base, North Dakota	UH-1N	582nd HG	AFGSC	MT
413th FLTS	Duke Field, Florida	UH-1N	96th TW/OG	AFMC	ET
459th AS	Yokota Air Base, Japan	UH-1N	374th AW/OG	PACAF	YJ
512th RQS	Kirtland Air Force Base, New Mexico	UH-1N	58th SOW/OG	AETC	
Air National Guard units					
188th RQS (see Note 2)	Kirtland Air Force Base, New Mexico	UH-1N	150th SOW/OG	AETC	

Notes
1 Crews deliver Rotary-Wing Qualification Course (RWQC) and Specialized Undergraduate Pilot Training — Helicopter (SUPT-H).
2 Associate unit conducts training alongside the active duty 512th SOS.

A UH-1N helicopter assigned to the 40th Helicopter Squadron approaches a landing zone during an integrated recapture and recovery exercise at an intercontinental ballistic missile launch facility near Simms, Montana. US Air Force/Airman 1st Class Jacob Thompson

HH-60G, HH-60U Pave Hawk, HH-60W Jolly Green II

The HH-60G Pave Hawk is tasked with the combat search and rescue (CSAR) role recovering isolated personnel from hostile territory. It is equipped with an external refuelling boom and probe that enables it to refuel from HC-130, KC-130 and MC-130 tankers. Mission equipment includes colour weather radar, an electro-optical/infra-red sensor, radar warning receiver, chaff/flare dispensers, infrared jamming system, hover infrared suppression system, defensive weapons and a hydraulic rescue hoist. The Pave Hawk's systems include a low-altitude warning system and satellite communications and a night vision goggle compatible cockpit. Pave Hawks are assigned to active-duty Air Force units as well as the Air National Guard (ANG) and Air Force Reserve Command. The helicopters are based at several locations in the CONUS as well as Alaska, Japan, and Italy.

After attrition reduced the HH-60G inventory to just 97 airframes, the Air Force began a program to restore the fleet to its required size. Under the HH-60 Operational Loss Replacement (OLR) Mission Modification Program the Air Force acquired 21 'low-time' UH-60Ls from the US Army. As part of the OLR program the UH-60Ls are being modified to the latest HH-60G configuration. Delivery of the OLR HH-60Gs to the three ANG CSAR units began in August 2019 and by the end of FY2020 the fleet size had been expanded to include 104 Pave Hawks. Several years newer than the Guard's HH-60Gs, the recapitalised OLR helicopters are intended to serve as a stopgap until the units receive the newer model. Deliveries will be completed in 2021 when the Air Force plans to begin retiring high-time Pave Hawks.

At least 30 HH-60Gs are being equipped with the AAQ-45(V) Distributed Aperture Infrared Countermeasure (DAIRCM), designed to defeat vehicle-launched infrared-guided missiles and man-portable air-defence systems. The system is an integrated suite of missile warning, laser warning, hostile fire indicator, and infrared countermeasure components designed to protect rotary-wing aircraft from infrared missile threats. The installation was developed in response to a Joint Urgent Operational Needs Statement and the Air Force awarded Leonardo DRS a $35 million contract in December 2018. The first aircraft equipped with DAIRCM were fielded in March 2020. The sensor also includes hostile fire indication, laser warning, a limited degraded visual environment capability. The Air Force tested a limited capability configuration of the DAIRCM on an HH-60G over a two-month period that concluded in July 2018.

Although the Air Force will begin receiving new HH-60W combat rescue helicopters later this year, the ANG's three rescue wings are not scheduled to receive the new model until 2027.

The Air Force also operates three HH-60Us that are based on the UH-60M variant. Modified to rescue configuration by the Army Aviation and Missile Research Development and Engineering Center at Redstone Arsenal, Alabama, the HH-60Us are assigned to a 'non-deploying test unit' within Air Force Materiel Command. Delivery of the first HH-60U occurred in September 2011.

The program to replace the HH-60G with a new Combat Rescue Helicopter (CRH) began in June 2014, when Sikorsky Aircraft and Lockheed Martin received a $1.2-billion contract from the Air Force. The CRH, designated HH-60W, is based on the US Army's UH-60M variant. The Air Force plans to acquire 113 HH-60Ws at a cost of $9 billion. The first pair of combat-coded helicopters was delivered to the 41st Rescue Squadron at Moody Air Force Base, Georgia, on November 5, 2020. Training operations will stand up at Kirtland Air Force Base, New Mexico. The HH-60W will achieve initial operating capability in 2021. In February 2020, the Air Force named the HH-60W the Jolly Green II.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
Det 3, AFTC	Nellis Air Force Base, Nevada	HH-60U	AFMC/AFTC	AFMC	
33rd RQS	Kadena Air Base, Okinawa	HH-60G	18th Wing/ OG	PACAF	ZZ
Det 1, 33rd RQS	Osan Air Base, Republic of Korea	HH-60G	18th Wing/ OG	PACAF	ZZ
34th WPS	Nellis Air Force Base, Nevada	HH-60G	57th Wing/ USAFWS	ACC	WA
41st RQS	Moody Air Force Base, Georgia	HH-60G, HH-60W	23rd Wing/347th RQG	ACC	FT
55th RQS	Davis-Monthan Air Force Base, Arizona	HH-60G	355th Wing/ 563rd RQG	ACC	DM
56th RQS	Aviano Air Base, Italy	HH-60G	31st FW/OG	USAFE	AV
66th RQS	Nellis Air Force Base, Nevada	HH-60G	355th Wing/ 563rd RQG	ACC	DM
88th TES (see Note 1)	Nellis Air Force Base, Nevada	HH-60G	53rd Wing/ TEG	ACC	OT
Det. 2 88th TES	Duke Field, Florida	HH-60W	53rd Wing/ TEG	ACC	OT
413th FLTS	Duke Field, Florida	HH-60W	96th TW/OG	AFMC	ET
Det 1, 413th FLTS (see Note 2)	Nellis Air Force Base, Nevada	HH-60G	96th TW/OG	AFMC	
512th RQS	Kirtland Air Force Base, New Mexico	HH-60G	58th SOW/ OG	AETC	
Air National Guard units					
101st RQS	Francis S. Gabreski Airport/ Air National Guard Base, Westhampton Beach, New York	HH-60G	106th RQW/ OG	ACC	
129th RQS	Moffett Federal Airport Air National Guard Station, California	HH-60G	129th RQW/ OG	ACC	CA
188th RQS (see Note 3)	Kirtland Air Force Base, New Mexico	HH-60G	150th SOW/ OG	AETC	
210th RQS	Joint Base Elmendorf-Richardson, Alaska	HH-60G	176th Wing/ OG	PACAF	
Det 1, 210th RQS	Eielson Air Force Base, Alaska	HH-60G	176th Wing/ OG	PACAF	
Air Force Reserve Command units					
301st RQS	Patrick Air Force Base, Florida	HH-60G	920th RQW/ OG	ACC	FL
305th RQS	Davis-Monthan Air Force Base, Arizona	HH-60G	920th RQW/943rd RQG	ACC	DR

Notes
1 Squadron utilises aircraft assigned to host wing. Combat Search and Rescue Combined Task Force (CSAR/CTF).
2 Det 1, 413th FLTS is part of the Combat Search and Rescue Combined Test Force.
3 Associate unit conducts training alongside the active duty 512th SOS.

MH-139A Grey Wolf

Boeing delivered the first of 84 MH-139As on December 19, 2019 to Eglin Air Force Base's Duke Field, and named it Grey Wolf the same day. The Air Force selected a variant of the Leonardo AW139 helicopter as a successor for its fleet of UH-1N Twin Huey helicopters on September 24, 2018. Boeing, which serves as the prime contractor, is teamed with Leonardo's AgustaWestland Philadelphia Corporation for the project.

MH-139A Grey Wolf serial 18-1002 lands at Duke Field, Florida. US Air Force/ Samuel King Jr

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
413th FLTS	Duke Field, Florida	MH-139A	96th TW/OG	AFMC	
Det. 7	Duke Field, Florida	MH-139A		AFGSC	

Four MH-139As will support testing, which is being carried out by the 413th Flight Test Squadron and supported by Detachment 7 at Duke Field, Florida. An Air Force and Boeing flight crew conducted the helicopter's first combined test in February 2020.

The MH-139A program is expected to enter low rate initial production when it achieves Milestone C in late 2021. Procurement plans for FY2021 include eight MH-139As. Initial operational test and evaluation will be carried out by Detachment 7 at Malmstrom Air Force Base, Montana, in 2022 and the MH-139A will achieve initial operating capability in late 2023. Full rate production will commence in the second quarter of FY2023. The service plans to spend $2.8 billion on MH-139 procurement in FY2021-2025. On November 20, 2020, Maxwell Air Force Base, Alabama, was named as the preferred location for the MH-139A formal training unit. The mission will be assigned to Air Force Reserve Command's 908th Airlift Wing, which currently operates the C-130H. The first helicopters will arrive at Maxwell in 2023.

MQ-1B Predator

The Air Force formally retired the General Atomics MQ-1B at Creech Air Force Base, Nevada, on March 9, 2018; however, five of the remotely piloted aircraft were still supporting test and evaluation duties at the end of FY2020. Then known as the RQ-1A, the unmanned Predator was first deployed operationally to Gjader, Albania, in July 1995.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
Det 1, 31st TES	Grey Butte FTOF, Palmdale, California	MQ-1B	53rd Wing/ TEG	ACC	CH
556th TES (see Note 1)	Creech Air Force Base, Nevada	MQ-1B	53rd Wing/ TEG	ACC	CH

Note 1 Squadron utilises aircraft assigned to host wing.

RQ-4B Global Hawk

The Block 30 RQ-4B version first flew at Air Force Plant 42 in Palmdale, California, in November 2007 and achieved initial operating capability in August 2011. It is a multi-intelligence platform and is capable of carrying the enhanced integrated sensor suite (E-ISS), synthetic aperture radar, and high and low-band SIGINT sensors simultaneously.

Three Block 30I RQ-4Bs were modified to Block 30M configuration and equipped with Airborne Signals Intelligence Payload (ASIP) payloads. Plans are underway to modify eight additional air vehicles to ASIP-capable Block 30M models.

The first of 11 Block 40 RQ-4Bs was rolled out at Plant 42 in June 2009 and the new variant conducted its initial flight that November. The Block 40 made its combat debut in support of CENTCOM in September 2013 when it carried out an early operational capability deployment. The Block 40 is equipped with the Northrop Grumman ZPY-2 active electronically scanned array radar that features moving target indicator and synthetic aperture radar capabilities. One Block 40 variant was lost in a 2018 mishap.

Upgrades also made the Block 30 RQ-4B compatible with the UTC Aerospace Systems MS-177 multi-spectral imaging camera, which replaced the E-ISS on two Global Hawks. Developed from the U-2S's Senior Year Electro-Optical Reconnaissance System, the system provides high-resolution multi-sensor imaging capability with automatic geolocation capabilities from high-altitude at stand-off ranges. The final three Block 30 RQ-4Bs were configured with the payload adaptor during construction. The air vehicles were purchased under Lot 11.

In addition to two air vehicles, each Global Hawk system consists of a launch and recovery element and a mission control element. The Global Hawk programme delivered 11 MCEs and 13 LREs.

The Air Force inventory currently includes 34 Global Hawks comprising four Block 20 EQ-4Bs, 20 Block 30s and ten Block 40 RQ-4Bs. The service's FY2021 budget included plans to retire the entire fleet of Block 30 RQ-4Bs. It had earlier revealed plans to replace the Block 20 EQ-4Bs with additional manned E-11A aircraft.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
7th RS	NAS Sigonella, Italy	RQ-4B	319th RW/OG	ACC	BB
Det 2, 53rd TEG (see Note 1)	Beale Air Force Base, California	RQ-4B	53rd Wing	ACC	BB
Det 1, 319th OG	Andersen Air Force Base, Guam	RQ-4B (Block 40)	319th RW/OG	ACC	GF
Det. 2, 319th OG	Beale Air Force Base, California	RQ-4B (Block 30)	319th RW/OG	ACC	GF
12th RS	Beale Air Force Base, California	RQ-4B (Block 30)	319th RW/OG	ACC	GF
348th RS	Grand Forks Air Force Base, North Dakota	EQ-4B, RQ-4B (Block 40)	319th RW/OG	ACC	GF
31st TES (see Note 1)	Edwards Air Force Base, California	RQ-4B	53rd Wing	ACC	ED
452nd FLTS	Edwards Air Force Base, California	RQ-4B	412th TW/OG	AFMC	ED
Air Force Reserve Command units					
13th RS (see Note 2)	Beale Air Force Base, California	RQ-4B	926th Wing/726th OG	ACC	BB

Notes
1 Squadron utilises aircraft assigned to host wing.
2 13th RS is an associate unit and is integrated with the 9th RW.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
3rd SOS	Cannon Air Force Base, New Mexico	MQ-9A	27th SOW/ OG	AFSOC	
6th ATKS (FTU)	Holloman Air Force Base, New Mexico	MQ-9A	49th Wing/ OG	AETC	HO
9th ATKS (FTU)	Holloman Air Force Base, New Mexico	MQ-9A	49th Wing/ OG	AETC	HO
11th ATKS (FTU)	Creech Air Force Base, Nevada	MQ-9A	432nd Wing/ OG	ACC	CH
12th SOS (see Note 1)	Cannon Air Force Base, New Mexico	MQ-9A	27th SOW/ OG	AFSOC	
15th ATKS	Creech Air Force Base, Nevada	MQ-9A	432nd Wing/ 732nd OG	ACC	CH
17th ATKS	Creech Air Force Base, Nevada	MQ-9A	432nd Wing/732nd OG	ACC	CH
20th ATKS	Whiteman Air Force Base, Nevada	MQ-9A RSO	432nd Wing/ 25th ATKG	ACC	CH
22nd ATKS	Creech Air Force Base, Nevada	MQ-9A	432nd Wing/732nd OG	ACC	CH
26th WPS (see Note 2)	Creech Air Force Base, Nevada	MQ-9A	57th Wing/ USAFWS	ACC	CH
29th ATKS (FTU)	Holloman Air Force Base, New Mexico	MQ-9A	49th Wing/ OG	AETC	HO
30th RS	Tonopah Test Range, Nevada	MQ-9A	432nd Wing/ OG	ACC	
Det 1, 31st TES	Grey Butte FTOF, Palmdale, California	MQ-9A	53rd Wing/ TEG	ACC	
33rd SOS	Cannon Air Force Base, New Mexico	MQ-9A	27th SOW/ OG	AFSOC	
42nd ATKS (see Note 3)	Creech Air Force Base, Nevada	(MQ-9A)	432nd Wing/25th ATKG	ACC	CH
50th ATKS	Shaw Air Force Base, South Carolina	MQ-9A RSO	432nd Wing/25th ATKG	ACC	
65th SOS	Hurlburt Field, Florida	MQ-9A RSO	1st SOW/ SOG	AFSOC	
89th ATKS	Ellsworth Air Force Base, South Dakota	MQ-9A RSO	432nd Wing/ OG	ACC	
Det 1, 452nd FLTS	Grey Butte FTOF, Palmdale, California	MQ-9A	412th TW/ OG	AFMC	
482nd ATKS	Shaw Air Force Base, South Carolina	MQ-9A RSO	432nd Wing/25th ATKG	ACC	
489th ATKS	Creech Air Force Base, Nevada	MQ-9A	432nd Wing/ OG	ACC	CH
491st ATKS (see Note 4)	Hancock Field Air National Guard Base, New York	MQ-9A	49th Wing/ OG	AETC	
556th TES (see Note 2)	Creech Air Force Base, Nevada	MQ-9A	53rd Wing/ TEG	ACC	CH
867th ATKS	Creech Air Force Base, Nevada	MQ-9A	432nd Wing/732nd OG	ACC	CH
Det. 3 AFMC	NAWS China Lake, California	MQ-9A	AFMC	AFMC	
Air Force Reserve Command units					
103rd ATKS	Horsham AGS, Pennsylvania	MQ-9A RSO	111th ATKW/ OG	ACC	
105th ATKS	Nashville International Airport-Joint Base Berry Field, Tennessee	MQ-9A RSO	118th Wing/ OG	ACC	
108th ATKS (FTU)	Syracuse Hancock International Airport, New York	MQ-9A	174th ATKW/ OG	ACC	
111th ATKS	Ellington Field JRB, Houston, Texas	MQ-9A	147th ATKW/ OG	ACC	EL
124th ATKS	Des Moines International Airport, Iowa	MQ-9A RSO	132nd Wing/ OG	ACC	
136th ATKS	Niagara Falls ARS International Airport, New York	MQ-9A RSO	107th ATKW/ OG	ACC	
138th ATKS	Syracuse Hancock International Airport, New York	MQ-9A	174th ATKW/ OG	ACC	
162nd ATKS	Springfield-Beckley Municipal Airport, Ohio	MQ-9A RSO	178th Wing/ OG	ACC	
172nd ATKS	W. K. Kellogg Regional Airport/Air National Guard Base, Battle Creek, Michigan	MQ-9A RSO	110th ATKW/ OG	ACC	
178th ATKS	Hector International Airport, Fargo, North Dakota	MQ-9A	119th Wing/ OG	ACC	
184th ATKS	Fort Smith Regional Airport/Ebbing Air National Guard Base, Arkansas	MQ-9A RSO	188th Wing/ OG	ACC	
196th ATKS	March ARB, California	MQ-9A	163rd ATKW/ OG	ACC	
214th ATKS	Davis-Monthan Air Force Base, Arizona	MQ-9A	162nd Wing/214th ATKG	ACC	AZ
232nd OS (see Note 5)	Creech Air Force Base, Nevada	MQ-9A	152nd AW/ OG	ACC	CH
Det 1 147th OG (see Note 6)	Joint Base San Antonio – Randolph, Texas	MQ-9A	147th ATKW/ OG	AETC	
Air Force Reserve Command units					

2nd SOS	Hurlburt Field, Florida	MQ-9A RSO	919th SOW/OG	AFSOC	
78th ATKS (see Note 7)	Creech Air Force Base, Nevada	MQ-9A	926th Wing/726th OG	ACC	CH
91st ATKS (see Note 7)	Creech Air Force Base, Nevada	MQ-9A	926th Wing/726th OG	ACC	CH
429th ACTS (see Note 8)	Holloman Air Force Base, New Mexico	MQ-9A	926th Wing/726th OG	ACC	HO

Notes
1 LRE Operations
2 Squadron utilises aircraft assigned to host wing.
3 The 42nd ATKS put into a 'dormant' status after flying its final mission on January 31, 2020.
4 491st ATKS active associate unit activated May 8, 2019.
5 Associate squadron integrated with the US Air Force AWC and the 432nd Wing. Primarily supports 556th TES MQ-9A operational test and evaluation mission.
6 Det 1, 147th OG supports training conducted by the 12th FTW's 558th FTS.
7 The 78th ATKS and 91st ATKS are associate units and are integrated with the 432nd Wing.
8 429th ACTS operate MQ-9As assigned to the 49th Wing.

MQ-9A Reaper

The MQ-9A Reaper remotely piloted aircraft (RPA) delivers a persistent capability to find, fix, track, target, engage and assess time sensitive targets (TST) with the flexibility to prosecute critical emerging targets.

The improved Block 5 variant features improved main landing gear, upgraded electrical system, additional radios, encrypted datalinks, a redesigned avionics bay and digital electronic engine control system, the BRU-71 bomb rack and HD video.

Fielding of the Extended Range Reaper by Air Force Special Operations Command began in 2015. Developed as a Quick Reaction Capability the modifications install new wings that contain extra fuel tanks and winglets and are capable of carrying external fuel tanks that increase endurance from 27 to 35 hours. Additionally, a four-blade propeller, anti-ice/de-ice system and a new fuel management system are incorporated. Operational testing was completed in September 2015 and the Air Force approved fielding in November 2015. Although the service initially procured 38 modification kits in response to a Joint Urgent Operational Needs Statement it plans to convert its Block 5 Reapers to ER configuration under the Follow-On Reaper Capability Enhancement project. The service is also updating the Lynx radar systems to the latest Block 20A configuration.

The Air Force named Tyndall Air Force Base, Florida, as the preferred alternative for stationing a new MQ-9A attack wing in November 2017. Although the base suffered catastrophic damage when Hurricane Michael struck in October 2018, 24 Reapers are expected to arrive by 2023.

As of September 30, 2020, there were 289 MQ-9As in service. The MQ-9A surpassed 2 million flight hours in 2019, over 90% of which were in support of combat operations. The Air Force's planned procurement of the MQ-9A concluded with its FY2020 purchase of 24 Reapers. The last of the 337 MQ-9As for the service will be delivered in 2024.

The Air Force continues to integrate new weapons with the Reaper and General Atomics is currently integrating the GBU-39B/B laser-guided Small Diameter Bomb. Integration should be completed by November 2021.

The Reaper's 'persistent attack' capabilities have recently been expanded as part of the operational flight program update that permits carriage of eight AGM-114 Hellfire missiles carried on the inboard stations, doubling its capacity.

The Air Force has also conducted live firings of AIM-9X Block 2 missiles from the MQ-9A. During a recent test, an MQ-9A crew received off-board cueing information, found and tracked a BQM-167 drone simulating a cruise missile, and manoeuvred the Reaper to employ the AIM-9X against the target.

In June 2020, the Air Force released a request for information associated with the development of a next-generation unmanned aircraft to replace the MQ-9. The service intends to accept the first such air vehicle in 2030 with fielding following in 2031.

RQ-170A Sentinel

First sighted around Kandahar Airfield, Afghanistan as early as 2007. the RQ-170A is a low-observable unmanned aircraft system. The program remains classified; however, the Air Force confirmed the existence of the remotely piloted aircraft in December 2009. It recently revealed that the RQ-170 had been deployed to the Republic of Korea's Kunsan Air Base in September 2009. The stealthy single-engine, flying wing was developed by Lockheed Martin's Skunk Works. Sentinels are tasked as intelligence, surveillance and reconnaissance assets and are operated by Air Combat Command's 432nd Wing from Creech Air Force Base and the Tonopah Test Range in Nevada.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
30th RS	Tonopah Test Range, Nevada	RQ-170A	432nd Wing/732nd OG	ACC	
44th RS	Creech Air Force Base, Nevada	RQ-170A	432nd Wing/OG	ACC	

T-1A Jayhawk

The T-1A is a missionized version of the Beechjet 400A, which in turn was based on the Mitsubishi MU-300 Diamond that first flew in August 1978. The Beechjet model 400T was named as the winner of a Air Force competition for a Tanker/Transport Training System in February 1990.

First flown in 1991, the T-1A supports the airlift/tanker track of the Air Force Specialized Undergraduate Pilot Training and Undergraduate Combat Systems Officer (CSO) training programs. The 21 T-1As modified for CSO training between 2010 and 2014, feature a GPS-driven synthetic radar and simulated radar warning receiver in the right seat flight deck position for use by a student CSO. A second student station and an instructor station were also added in the main cabin. Deliveries to Reese Air Force Base, Texas, began in January 1992 and student training followed in 1993. The Air Force received 180 T-1As, and 178 are currently carried on the inventory.

The T-1A Avionics Modification Program (AMP) is updating the Jayhawk with new commercial off-the-shelf equipment that will permit the trainers to meet current and planned domestic and international air traffic control requirements. The upgrade provided ADS-B Out capability that allows the T-1A to meet Federal Aviation Administration requirements and ensures access to the National Airspace System.

Field Aerospace's Aerospace Systems Engineering and Support subsidiary carried out the first flight of an AMP T-1A at Will Rogers World Airport in Oklahoma City, Oklahoma, on March 22, 2019.

In February 2018, Field received a contract to modernize the T-1A aircraft and fleet modifications should be completed by 2025. The AMP will allow the T-1A to remain in service until the 2050 timeframe, however; plans to upgrade the entire T-1A fleet may be curtailed as a result of the US Air Force's plan to divest 156 of the Jayhawks beginning in 2023. If the retirement moves forward, just 55 T-1As, including the 21 CSO trainers will receive the AMP.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
3rd FTS	Vance Air Force Base, Oklahoma	T-1A	71st FTW/OG	AETC	VN
48th FTS	Columbus Air Force Base, Mississippi	T-1A	14th FTW/OG	AETC	CB
86th FTS	Laughlin Air Force Base, Texas	T-1A	47th FTW/OG	AETC	XL
99th FTS	Joint Base San Antonio-Randolph, Texas	T-1A	12th FTW/OG	AETC	RA
451st FTS	Naval Air Station Pensacola, Florida	T-1A	12th FTW/479th FTG	AETC	AP
Air Force Reserve Command units					
5th FTS (see Note 1)	Vance Air Force Base, Oklahoma	T-1A	340th FTG	AETC	VN
39th FTS (see Note 1)	Joint Base San Antonio-Randolph, Texas	T-1A	340th FTG	AETC	RA
43rd FTS (see Note 1)	Columbus Air Force Base, Mississippi	T-1A	340th FTG	AETC	CB
96th FTS (see Note 1)	Laughlin Air Force Base, Texas	T-1A	340th FTG	AETC	XL

Note 1 AETC-gained associate unit that provides instructor pilots for T-1A and utilises aircraft assigned to host wing.

T-6A Texan II

Selected as the winner of the Joint Primary Aircraft Training System competition in June 1995, the Beechcraft T-6A design was developed from the Pilatus PC-9 turboprop. The Texan II was intended to replace both the US Air Force's T-37B and the US Navy's T-34C primary trainers. Flown for the first time at Beech Field, Wichita, Kansas, in July 1998, the T-6A achieved Initial operational capability with the Air Force in July 2002. Instructor pilot training began earlier at Randolph Air Force Base, Texas in 2000 and student flights commenced at Moody Air Force Base, Georgia in October 2001. Beechcraft delivered the last of 454 Texan IIs to the 479th Flying Training Group at Naval Air Station Pensacola, Florida, in May 2010.

A fleet of 442 T-6As supports Joint Primary Pilot Training at five Air Education and Training Command bases, and the primary phase of Undergraduate Combat Systems Officer Training program at Pensacola. The trainers are flown by 10 active-duty flying training squadrons that are supported by five Air Force Reserve Command associate squadrons.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
8th FTS	Vance Air Force Base, Oklahoma	T-6A	71st FTW/OG	AETC	VN
33rd FTS	Vance Air Force Base, Oklahoma	T-6A	71st FTW/OG	AETC	VN
37th FTS	Columbus Air Force Base, Mississippi	T-6A	14th FTW/OG	AETC	CB
41st FTS	Columbus Air Force Base, Mississippi	T-6A	14th FTW/OG	AETC	CB
85th FTS	Laughlin Air Force Base, Texas	T-6A	47th FTW/OG	AETC	XL
89th FTS	Sheppard Air Force Base, Texas	T-6A	80th FTW/OG	AETC	EN
434th FTS	Laughlin Air Force Base, Texas	T-6A	47th FTW/OG	AETC	XL
455th FTS	Naval Air Station Pensacola, Florida	T-6A	12th FTW/479th FTG	AETC	AP
459th FTS	Sheppard Air Force Base, Texas	T-6A	80th FTW/OG	AETC	EN
559th FTS	Joint Base San Antonio-Randolph, Texas	T-6A	12th FTW/OG	AETC	RA
Air Force Reserve Command units					
5th FTS (see Note 1)	Vance Air Force Base, Oklahoma	T-6A	340th FTG	AETC	VN
39th FTS (see Note 1)	Joint Base San Antonio-Randolph, Texas	T-6A	340th FTG	AETC	RA
43rd FTS (see Note 1)	Columbus Air Force Base, Mississippi	T-6A	340th FTG	AETC	CB
96th FTS (see Note 1)	Laughlin Air Force Base, Texas	T-6A	340th FTG	AETC	XL
97th FTS (see Note 1)	Sheppard Air Force Base, Texas	T-6A	340th FTG	AETC	EN

Note
1 AETC-gained associate unit, provides instructor pilots for T-6A, and utilises aircraft assigned to host wing.

T-38A, T-38C, AT-38B, AT-38C Talon

The Air Force currently operates hundreds of T-38Cs for the advanced phase of Air Education and Training Command's Specialized Undergraduate Pilot Training program and as lead-in fighter trainers. T-38Cs also support Pilot Instructor Training at Randolph Air Force Base, Texas, and the Euro-NATO Joint Jet Pilot Training program at Sheppard Air Force Base, Texas. The 16 T-38Cs assigned to Air Force Materiel Command support the US Air Force Test Pilot School and test and evaluation efforts at Edwards Air Force Base, California, and Holloman Air Force Base, New Mexico.

Although they were retired from duties in May 2007, 53 T-38As along with six AT-38Bs continue to serve as companion trainers and as aggressor aircraft in support of the B-2, F-22 and U-2 fleets.

The 575th Aircraft Maintenance Squadron is currently carrying out Pacer Classic III modifications to replace specific life-limited components to ensure structural sustainment of the airframe. The modifications also increase the Talon's service life to 20,000 hours and will permit the Air Force to operate the trainer until 2029. Under current plans 180 T-38Cs will receive the Pacer Classic III mods by 2021.

The current inventory of 502 Talons comprises 53 T-38A, six AT-38B and 443 T-38C models.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
1st RS (FTU)	Beale Air Force Base, California	T-38A	9th RW/OG	ACC	BB
2nd FTRS	Tyndall Air Force Base, Florida	T-38A, AT-38B	325th FW/OG	ACC	TY
25th FTS	Vance Air Force Base, Oklahoma	T-38C	71st FTW/OG	AETC	VN
49th FTRS	Columbus Air Force Base, Mississippi	AT-38C	14th FTW/OG	AETC	CB
50th FTS	Columbus Air Force Base, Mississippi	T-38C	14th FTW/OG	AETC	CB
71st FTRS	Joint Base Langley-Eustis, Virginia	T-38A, AT-38B	1st FW/OG	ACC	FF
87th FTS	Laughlin Air Force Base, Texas	T-38C	47th FTW/OG	AETC	XL
88th FTRS	Sheppard Air Force Base, Texas	AT-38C	80th FTW/OG	AETC	EN
90th FTS	Sheppard Air Force Base, Texas	T-38C	80th FTW/OG	AETC	EN
99th RS	Beale Air Force Base, California	T-38A	9th RW/OG	ACC	BB
394th CTS (FTU)	Whiteman Air Force Base, Missouri	T-38A	509th BW/OG	AFGSC	WM
416th FLTS	Edwards Air Force Base, California	T-38C	412th TW/OG	AFMC	ED
435th FTRS	Joint Base San Antonio-Randolph, Texas	AT-38C	12th FTW/OG	AETC	RA
469th FTS	Sheppard Air Force Base, Texas	T-38C	80th FTW/OG	AETC	EN
560th FTS	Joint Base San Antonio-Randolph, Texas	T-38C	12th FTW/OG	AETC	RA
586th FLTS	Holloman Air Force Base, New Mexico	T-38C	AEDC/704th TESTG	AFMC	HT
Air Force Reserve Command units					
5th FTS (see Note 1)	Vance Air Force Base, Oklahoma	T-38C	340th FTG	AETC	VN
39th FTS (see Note 1)	Joint Base San Antonio-Randolph, Texas	T-38C, AT-38C	340th FTG	AETC	RA
43rd FTS (see Note 1)	Columbus Air Force Base, Mississippi	T-38C, AT-38C	340th FTG	AETC	CB
96th FTS (see Note 1)	Laughlin Air Force Base, Texas	T-38C	340th FTG	AETC	XL
97th FTS (see Note 1)	Sheppard Air Force Base, Texas	T-38C, AT-38C	340th FTG	AETC	EN

Note
1 AETC-gained associate unit, provides instructor pilots for T/AT-38C, and utilises aircraft assigned to host wing.

T-7A Red Hawk

The Air Force announced the selection of the Boeing/Saab-designed single-engine BTX-1 design as the winner of its T-X Advanced Pilot Training aircraft competition on September 27, 2018. The service subsequently revealed the assignment of the designation and name T-7A Red Hawk to its new supersonic advanced trainer on September 16, 2019.

Boeing will deliver five aircraft and seven flight training devices to the 12th Flying Training Wing at Joint Base San Antonio–Randolph, Texas, under its initial $813-million engineering manufacturing and development phase. Deliveries to Randolph will begin in in 2023 and the trainer is expected to achieve initial operational capability in late 2024. Full operational capability will follow in 2034. The Air Force's plans include the acquisition of 351 T-7As and 46 simulators

Two low-rate initial production lots will be followed by at least eight full-rate production lots and the program could be worth as much as $9.2 billion. Although the Red Hawk will initially replace Air Education and Training Command's T-38Cs, subsequent purchases could see the T-7A also replace Talons used as aggressor and companion trainers, which could increase production to include as many as 475 aircraft and 120 training devices.

The T-7A is powered by a single General Electric F404 turbofan and features Collins Aerospace ACES 5 ejection seats.

Saab began construction of the first T-7A aft fuselage section at its Linköping, Sweden, facility in January 2020. The Red Hawk will undergo final assembly at Boeing's St Louis, Missouri, facility. Saab will carry out future production work at a new facility in West Lafayette, Indiana.

U-28A Draco

Operated exclusively by Air Force Special Operations Command, the U-28A provides airborne intelligence, surveillance, reconnaissance (AISR) and targeting in support of Theater Special Operations Forces. It is based on the single-engine Pilatus PC-12.

Assigned to Air Force Special Operations Command's light tactical fixed wing fleet, the aircraft were modified for use in support of Operations Enduring Freedom and Iraqi Freedom from 2006.

Modifications equipped the PC-12s with military specific communications and aircraft survivability equipment , electro-optical/infrared sensors, and advanced navigation systems equipment. The U-28A crew is comprised of two pilots, a combat systems officer and a tactical systems officer.

The U-28 EQ+ modifications are providing the U-28A with 20in high definition full motion video sensor turrets and the MTS-B Multi-Spectral Targeting System. The sensor allows the U-28A to conduct extended stand-off operations and improves its find, fix, finish capability. Air Force Special Operations Command revealed the assignment of the popular name Draco to the U-28A in June 2019.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
14th WPS (see Note 1)	Hurlburt Field, Florida	U-28A	57th Wing/USAFWS	ACC	
19th SOS (FTU) (see Note 1)	Hurlburt Field, Florida	U-28A	492nd SOW/OG	AFSOC	
34th SOS	Hurlburt Field, Florida	U-28A	1st SOW/OG	AFSOC	
318th SOS	Cannon Air Force Base, New Mexico	U-28A	27th SOW/OG	AFSOC	
319th SOS	Hurlburt Field, Florida	U-28A	1st SOW/OG	AFSOC	
551st SOS (FTU) (see Note 1)	Cannon Air Force Base, New Mexico	U-28A	492nd SOW/OG	AFSOC	
Air Force Reserve Command units					
5th SOS (see Note 2)	Hurlburt Field, Florida	U-28A	919th SOW/OG	AFSOC	

Notes
1 Utilises aircraft assigned to host wing.
2 Associate squadron utilises aircraft assigned to host wing.

U-2S, TU-2S 'Dragon Lady'

First flown in August 1955 as the U-2A, the Dragon Lady is the Air Force's sole manned strategic reconnaissance asset. Under current plans, the U-2S is expected to continue in service through FY2025 when it plans to begin divesting the intelligence, surveillance, and reconnaissance aircraft.

The Air Force has reversed earlier plans to phase out the U-2S and is again planning to maintain and improve the operational capability of the platform. Planned upgrades will provide the U-2S with the Advanced Synthetic Aperture Radar System 2B (ASARS-2B) and Senior Year Electro-Optical Reconnaissance System-2C. The ASARS-2B, which is under development by Raytheon, will feature an active electronically scanned array radar and other new capabilities.

Lockheed delivered 12 U-2Rs and 18 similar TR-1As to the Air Force between 1967-1970 and 1981-1993 respectively. Although the two variants were structurally identical, the TR-1A was tailored for tactical reconnaissance. In 1991 the Air Force redesignated the TR-1As as U-2Rs. Beginning in 1984, the fleet was equipped with upgrades that included new General Electric F118-GE-101 turbofan engines. The updated single and two-seat models were respectively assigned the designations U-2S and TU-2S.

Squadron	Location	Aircraft	Wing/ Group	Command	Tail code
Det 1, 9th OG	RAF Akrotiri, Cyprus	U-2S	9th RW/OG	ACC	BB
Det 2, 53rd TEG (see Note 1)	Beale Air Force Base, California	U-2S	53rd Wing/ OG	ACC	BB
1st RS (FTU)	Beale Air Force Base, California	U-2S, TU-2S	9th RW/OG	ACC	BB
5th RS	Osan Air Base, Republic of Korea	U-2S	9th RW/OG	ACC	BB
99th RS	Beale Air Force Base, California	U-2S	9th RW/OG	ACC	BB
99th ERS	Al Dhafra, UAE	U-2S	9th RW/OG	ACC	BB

Note 1 Squadron utilises aircraft assigned to host wing.

Air Combat Command currently operates 27 single-seat U-2S and four two-seat TU-2S models that are assigned to the 9th Reconnaissance Wing at Beale Air Force Base.

U-2S Dragon Lady serial 80-1074/BB lands at Beale Air Force Base, California, home of the 9th Reconnaissance Wing. It is the only U-2-equipped wing in the Air Force. The bicycle-type landing gear and low-altitude handling characteristics of the U-2 require precise control inputs during landing.
US Air Force/Airman 1st Class Luis Ruiz-Vazquez

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
7th SOS	RAF Mildenhall, Suffolk, England	CV-22B	352nd SOW/352nd OG	AFSOC	
8th SOS	Hurlburt Field, Florida	CV-22B	27th SOW/OG	AFSOC	
14th WPS (see Note 1)	Hurlburt Field, Florida	CV-22B	57th Wing/ USAFWS	ACC	
20th SOS	Cannon Air Force Base, New Mexico	CV-22B	27th SOW/OG	AFSOC	
71st SOS	Kirtland Air Force Base, New Mexico	CV-22B	58th SOW/OG	AETC	
21st SOS	Yokota Air Base, Japan	CV-22B	353rd SOG	AFSOC	
Air National Guard units					
188th RQS (see Note 2)	Kirtland Air Force Base, New Mexico	CV-22B	150th SOW/ OG	AETC	

Notes
1 Utilises aircraft assigned to host wing.
2 Associate unit conducts training alongside the active duty 71st SOS.

CV-22B Osprey

Developed in parallel with the US Marine Corps MV-22B, the CV-22B is a Special Operations Forces (SOF) variant of the tiltrotor Osprey. The CV-22B entered service with the 1st Special Operations Wing at Hurlburt Field, Florida, in January 2007 and achieved initial operating capability with the 8th Special Operations Squadron in March 2009. The aircraft's first operational deployment began in March 2010, when six Ospreys arrived in Afghanistan.

The CV-22B can carry 18 combat-ready personnel and has a mission radius of 538nm. The tiltrotor's self-deployment capability allows it to travel up to 2,100nm with a single aerial refuelling and enables the CV-22B to execute special operations missions that include long-range infiltration, exfiltration, and resupply for SOF personnel. The CV-22B is equipped with an APQ-186 terrain-following radar, an electro-optical/infrared sensor and other advanced avionics systems that permit it to operate at low altitude in adverse weather conditions and in medium to high-threat environments.

The 413th Flight Test Squadron and the 18th Special Operations Test & Evaluation Squadron conducted the first flight of a CV-22B equipped with the Raytheon APQ-187 Silent Knight terrain following/terrain avoidance (TF/TA) radar system at Eglin Air Force Base, Florida, on June 23, 2020.

Retrofit of the TF/TA radar will be carried out by 2027 as part of the CV-22B Block 30 upgrade. The current Block 20 upgrade programme is providing the CV-22B with colour helmet mounted display kits, a suite of integrated RF countermeasures and the BAE Systems full-azimuth defensive weapon system (DWS). The remotely operated DWS incorporates a gunner station, targeting sensor and a 7.62mm GAU-17 mini-gun. Eight CV-22B Ospreys currently support training efforts at Kirtland Air Force Base, New Mexico and 42 are assigned to operational units.

A special ops troop rappels onto the deck of a ship from a CV-22 Osprey assigned to the 21st Special Operations Squadron during Exercise Gryphon Jet at Yokota Air Base, Japan, in June 2020. US Air Force/Yasuo Osakabe

A UV-18B Twin Otter aircraft taxies at the US Air Force Academy airfield in Colorado Springs carrying cadets participating in basic freefall parachute training. It is the only certified programme in the world where a student's very first jump is an unassisted freefall. US Air Force/Trevor Cokley

UV-18A, UV-18B Twin Otter

The US Air Force operates three de Havilland Canada DHC-6-300s from Peterson Air Force Base, Colorado in support of the US Air Force Academy. One UV-18A and two UV-18Bs are primarily used by the 98th Flying Training Squadron for parachute training.

US Air Force Gliders

The US Air Force Academy's soaring program is managed by the 94th Flying Training Squadron and operates several types of sailplanes. Based at the academy's Davis Airfield in Colorado Springs, Colorado, the aircraft include two Schempp-Hirth Discus 2b single-seat gliders and three Duo Discus models. Acquired in 2004, the gliders are respectively assigned the designations TG-15A and TG-15B. The programme also operates 19 two-seat DG-1001S Club gliders under the designation TG-16A. The TG-15As are used as competition and training gliders whereas the three TG-15Bs are tailored for advanced training and cross-country flying. Cadets typically fly 10-15 training sorties in the TG-15A, and complete a 50-hour cross-country soaring upgrade before they are permitted to fly cross-country solo in the TG-15B. Tow plane support for the gliders is provided by Cub Crafters CC18-180 Super Cubs operated by Akima Logistics Services on behalf of the academy. Akima also provides full contractor logistics support for the entire fleet of 58 aircraft assigned to the US Air Force Academy.

T-51A

Three Cessna 150s serve as the primary competition aircraft for the US Air Force Academy Flying Team in National Intercollegiate Flying Association events. The aircraft, which carry the designation T-51A, entered service in 1984 and are assigned to the 557th Flying Training Squadron.

T-41D Mescalero

Four Cessna Model 172s are operated by the 557th Flying Training Squadron under the designation T-41D. Acquired by the US Air Force Academy in 1969, the Mescaleros are primarily used for flying team support, tactical navigation, and orientation flights.

DA20-C1

L3 Doss Aviation conducts preliminary flight-training courses for pilots, combat systems officers, and remotely piloted aircraft students at its Pueblo Memorial Airport facility in Colorado, under contract to the US Air Force.

Managed by Air Education and Ttraining Command's 306th Flying Training Group, the Initial Flight Training program is supported by a fleet of Diamond Aircraft DA20-C1 trainers. Doss provides flight screening for 1,300 to 1,700 personnel annually.

T-53A Kaydet II serial 10-108/AF assigned to the 557th Flying Training Squadron based at the US Air Force Academy airfield in Colorado Springs. US Air Force Academy

T-53A Kaydet II

The Academy's Airmanship Training Program operates 24 Cirrus SR20s light aircraft under the designation T-53A. Purchased from Cirrus Aircraft in March 2011 the aircraft are assigned to the 557th Flying Training Squadron.

Squadron	Location	Aircraft	Wing/Group	Command	Tail code
1st FTS (see Note 1)	Pueblo Memorial Airport, Colorado	DA20-C1	12th FTW/306th FTG	AETC	AF
81st FTRS (see Note 2)	Moody Air Force Base, Georgia	A-29B	14th FTW/OG	AETC	
94th FTS	US Air Force Davis Airfield, Colorado Springs	TG-15A, TG-15B, TG-16A, TG-16B	12th FTW/306th FTG	AETC	AF
98th FTS	Peterson Air Force Base, Colorado	UV-18A, UV-18B	12th FTW/306th FTG	AETC	AF
557th FTS	US Air Force Davis Airfield, Colorado Springs	T-41D, T-51A, T-53A	12th FTW/306th FTG	AETC	AF
427th SOS	Pope Army Air Field, Fort Bragg, North Carolina	CN235, Cessna 208		AFSOC	
Det 1, 375th OG (see Note 3)	Will Rogers World Airport, Oklahoma City, Oklahoma	Challenger CL601, CL604	375th AMW/OG	AMC	
Air Force Reserve Command units					
1st ASF (see Note 4)	Will Rogers World Airport, Oklahoma City, Oklahoma	Challenger CL601, CL604	413th FTG/OG	AMC	
70th FTS (see Note 5)	US Air Force Academy Davis Airfield, Colorado Springs	TG-15A, TG-15B, TG-16A, UV-18A, UV-18B, T-41D, T-51A, T-53A	340th FTG	AETC	AF

Notes
1 1st FTS is responsible for IFT, which is conducted by Doss Aviation.
2 Squadron trains Afghan and Lebanese Air Force personnel using Super Tucano.
3 Unit conducts Combat Flight Inspection (CFIN) mission and utilises Challenger 601 aircraft owned by the Federal Aviation Administration (FAA).
4 Associate unit supports Det 1, 375th OG mission. Conducts Combat Flight Inspection (CFIN) missions and utilises Challenger 601 aircraft owned by the Federal Aviation Administration (FAA).
5 Associate unit supports 306th FTG operations at the US Air ForceA.

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